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EXECUTIVE DIGITAL COMPUTER PROGRAM FOR PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS DOCUMENTATION

Environmental Protection Agency

March 1973

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This computer program (FORTRAN, IBM 1130) can be used to compute the quasi-steady-state performance and cost of groups of conventional and advanced wastewater treatment unit processes arranged in any configuration. Each subroutine computes the performance and cost of a single unit process. An influent stream vector and decision variables are input. The program contains subroutines for simulating the following wastewater treatment processes: preliminary treatment, primary sedimentation, aerator-final settler, stream mixer, stream splitter, anaerobic digestion, vacuum filtration, gravity thickening, elutriation, sludge drying beds, trickling filter-final settler, chlorination, flotation thickening, multiple hearth incineration, raw wastewater pumping, sludge holding tanks, centrifugation, aerobic digestion, post aeration, equalization, second stage anaerobic digestion, land disposal of liquid sludge and lime addition to sludge. The report includes a program listing.

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EXECUTIVE
DIGITAL COMPUTER PROGRAM
FOR
PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS
DOCUMENTATION

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Federal Water Quality Administration
Advanced Waste Treatment Branch, Division of Research
Cincinnati, Ohio

March 1973

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INTRODUCTION

A digital computer program which can be used to compute the quasi-steady-state performance and cost of groups of conventional and advanced wastewater treatment processes arranged in any configuration has been developed at the Advanced Waste Treatment Research Laboratory of the Federal Water Quality Administration, United States Department of the Interior. This program is written in FORTRAN and is designed to run on a 16K IBM 1130 computer. The Executive program presently contains a main program and 12 process subroutines; each subroutine computes the performance and cost of a single wastewater treatment process. Two additional subroutines are provided. The first, entitled COST, sums the costs of the individual processes, adds engineering cost, contractor's profit, contingencies and omissions, and cost of land. The second subroutine entitled PRINT simply prints all pertinent data in a format which is described later in the section of this report entitled PRINTED OUTPUT FORMAT. The 12 processes presently included in the program together with the subroutine names are listed below:

PROCESS NAME	SUBROUTINE NAME
Preliminary Treatment	PREL
Primary Settler	PRSET
Aerator-Final Settler	AERFS
Trickling Filter-Final Settler	TRFS
Chlorination	CHLOR
Mixer	MIX
Splitter	SPLIT
Digester	DIG
Vacuum Filter	VACF
Sludge Thickener	THICK
Sludge Elutriation	ELUT
Sludge Drying Beds	SBEDS

Sample input cases, definitions of the FORTRAN variables, a listing of the entire FORTRAN program, a sample printout, and coding forms designed for preparing input to the program are all included in the APPENDIX to this report.

Federal Water Quality Administration sponsored work is now underway to provide subroutines for additional wastewater treatment processes. Subroutines for the following processes will be added to the program as they become available:

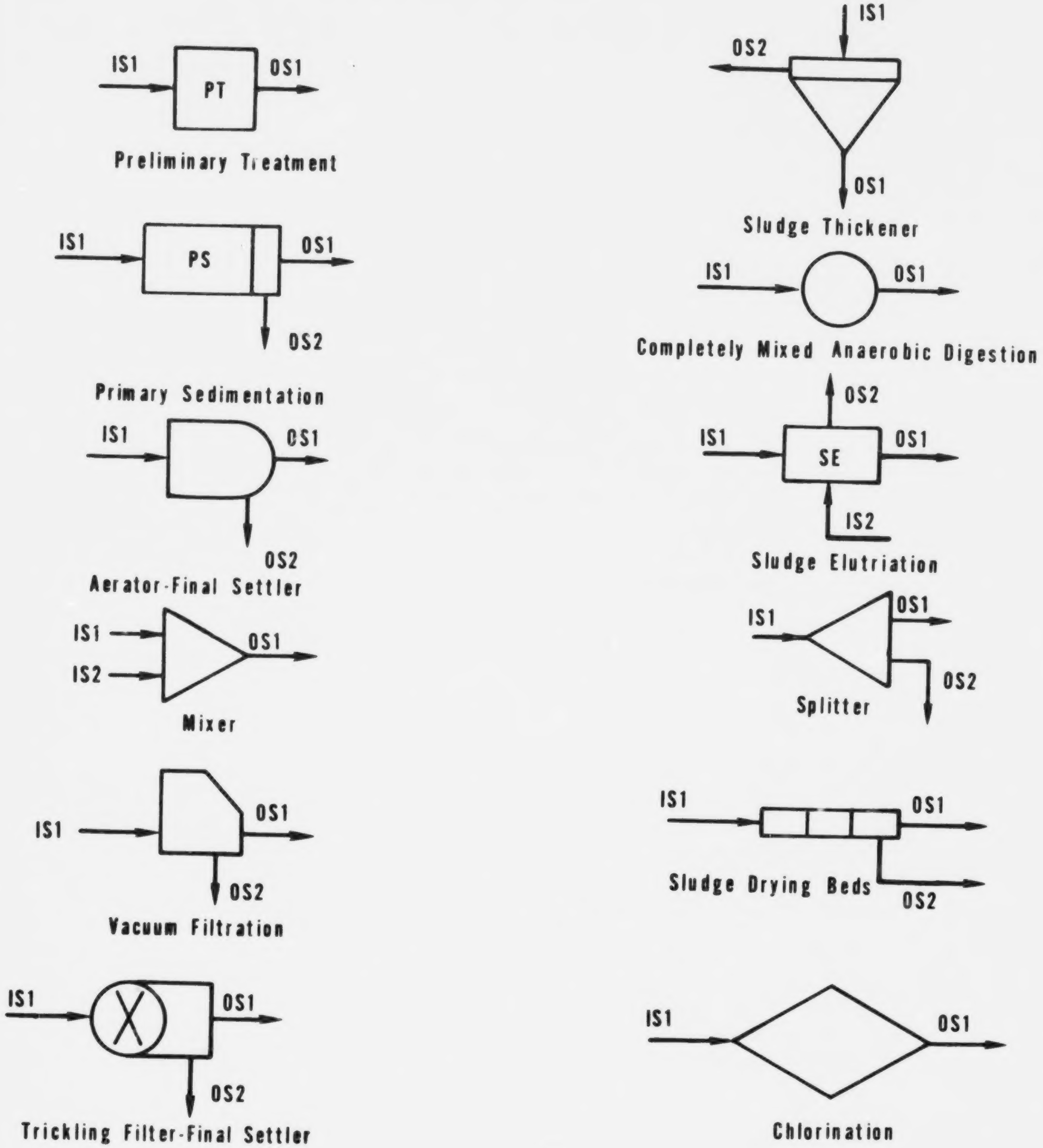
1. Final Clarifier for the Activated Sludge Process
2. Fluidized Bed Incineration of Sludges
3. Coagulation and Sedimentation of Secondary Effluent following Lime or Alum Addition
4. Ammonia Stripping of Secondary Effluent
5. Granular Carbon Adsorption
6. Ion Exchange
7. Electrodialysis
8. Reverse Osmosis
9. Influent Pumping Facilities
10. Bar Screen
11. Comminution
12. Grit Removal
13. Flow Measurement
14. Flotation Thickening
15. Plain Aeration
16. Waste Stabilization Ponds
17. Two-Stage Anaerobic Digestion
18. Aerobic Digestion
19. Centrifugation of Organic Sludges
20. Multiple Hearth Incineration
21. Microscreening
22. Rough Filtration
23. Multi-Media Filtration
24. Disinfection
25. Recarbonation Using CO_2

Two additional engineering analysis projects will provide better estimates of construction cost and operating and maintenance cost. Several large measurement programs will supply better empirical design data for secondary processes.

FIGURE 1

PROCESS SYMBOLS

Subroutines for these processes are presently in the program



Preliminary Treatment

Primary Sedimentation

Aerator-Final Settler

Mixer

Vacuum Filtration

Trickling Filter-Final Settler

Sludge Thickener

Completely Mixed Anaerobic Digestion

Sludge Elutriation

Splitter

Sludge Drying Beds

Chlorination

IS1
OS1
PT
IS1
PS
OS1
OS2
IS1
OS1
OS2
IS1
IS2
OS1
IS1
OS1
OS2
IS1
OS1
OS2
IS1
OS2
OS1
IS1
OS1
OS2
IS1
SE
OS1
IS2
IS1
OS1
OS2
IS1
OS1
OS2
IS1
OS1

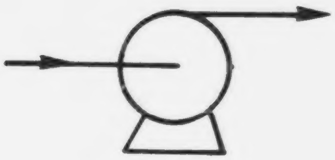
PROGRAM DESCRIPTION

The first step in using the program is to draw the process diagram showing the processes to be used and the connecting and recycle streams. For this purpose, the process symbols shown in FIGURES 1 to 3 are suggested. The process symbols for process subroutines not yet included in the program are also given. Example process diagrams are shown in FIGURE 4. Each process and each stream is assigned a number by the program user. The stream and process numbers that can be used are 1 through 25. The principal influent stream to the system is always assigned the number one (1), and the principal effluent stream from the system is always assigned the number twenty-five (25). The number zero (0) is given to processes involving no cost calculations or decisions (input parameters), such as the mixer or the splitter. Notice that the volume of the split stream must be supplied by some downstream process, such as sludge elutriation.

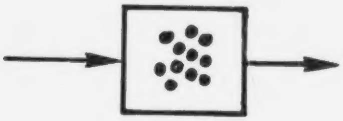
The program provides for initially reading in the influent and guess streams. For most cases, it is only necessary to supply the influent stream as input. All stream vectors are stored in the stream matrix (SMATX) which has 20 rows and 25 columns. One stream vector is stored in each column of SMATX. A temporary stream matrix (TMATX) with 20 rows and 25 columns is used internally by the program to store newly computed stream vectors until they can be compared with the previously computed values during the program's recycle iterations. The error (EPS) which will be tolerated when recycle streams are involved is also supplied as input to the program. The value for EPS normally used in the program is .10 mg/l. Each stream

FIGURE 2
PROCESS SYMBOLS

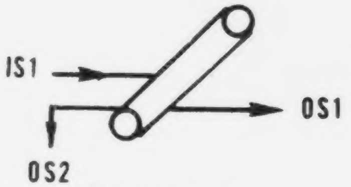
Subroutines for these processes are not presently in the program



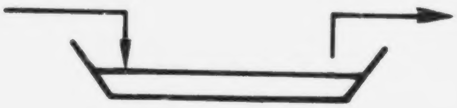
Influent Pumping Facilities



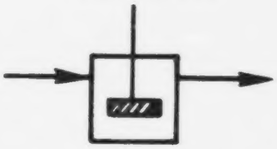
Plain Aeration



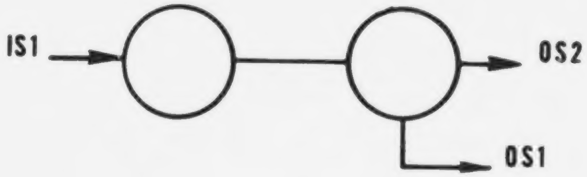
Bar Screen



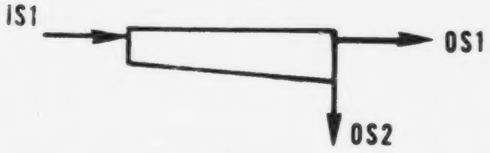
Waste Stabilization Ponds



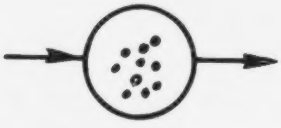
Comminution



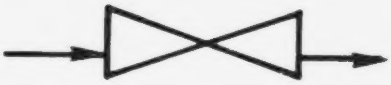
Two Stage Anaerobic Digestion



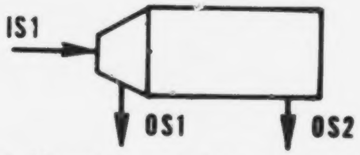
Grit Removal



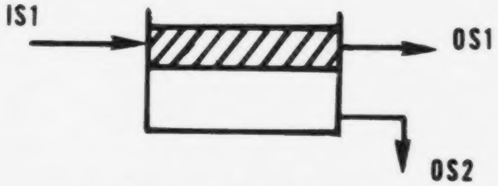
Aerobic Digestion



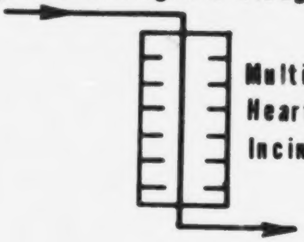
Flow Measurement



Centrifugation of Organic Sludges



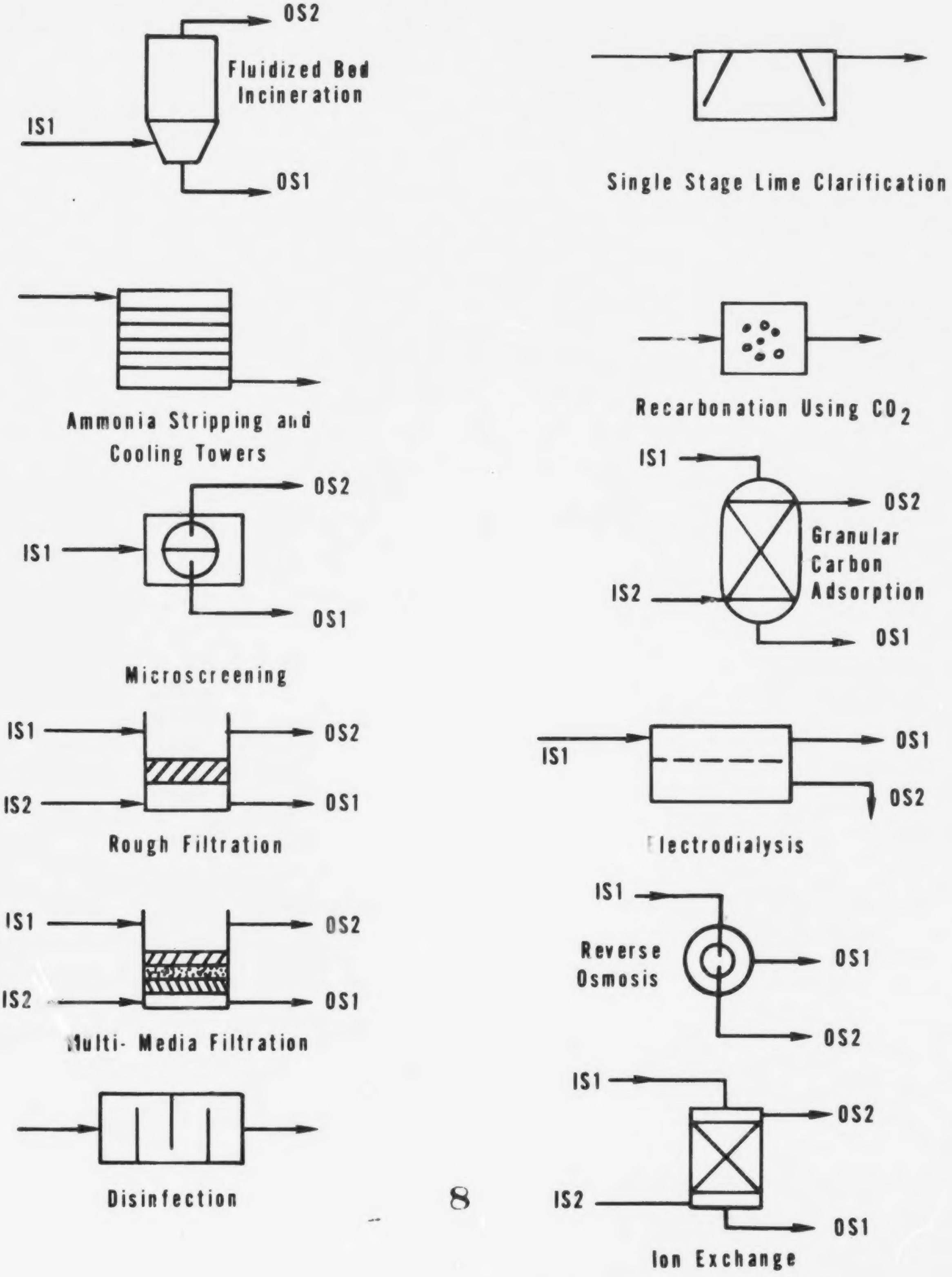
Flotation Thickening



Multiple Hearth Incineration

FIGURE 3
PROCESS SYMBOLS

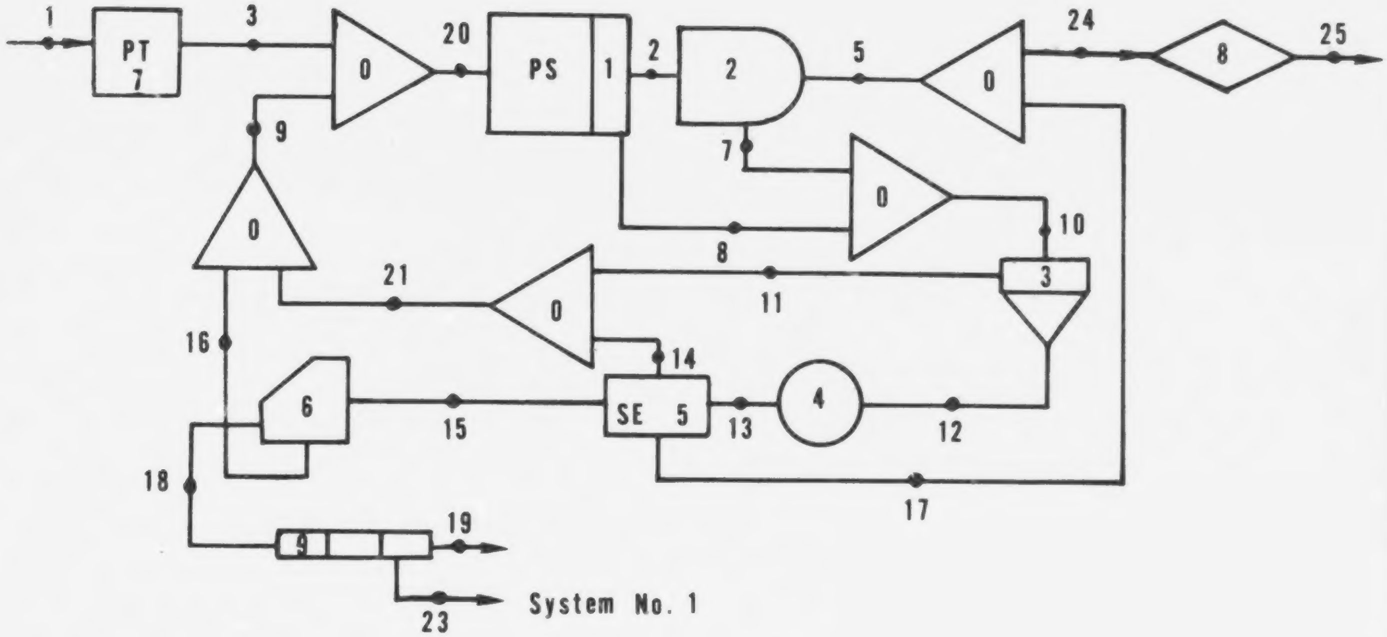
Subroutines for these processes are not presently in the program



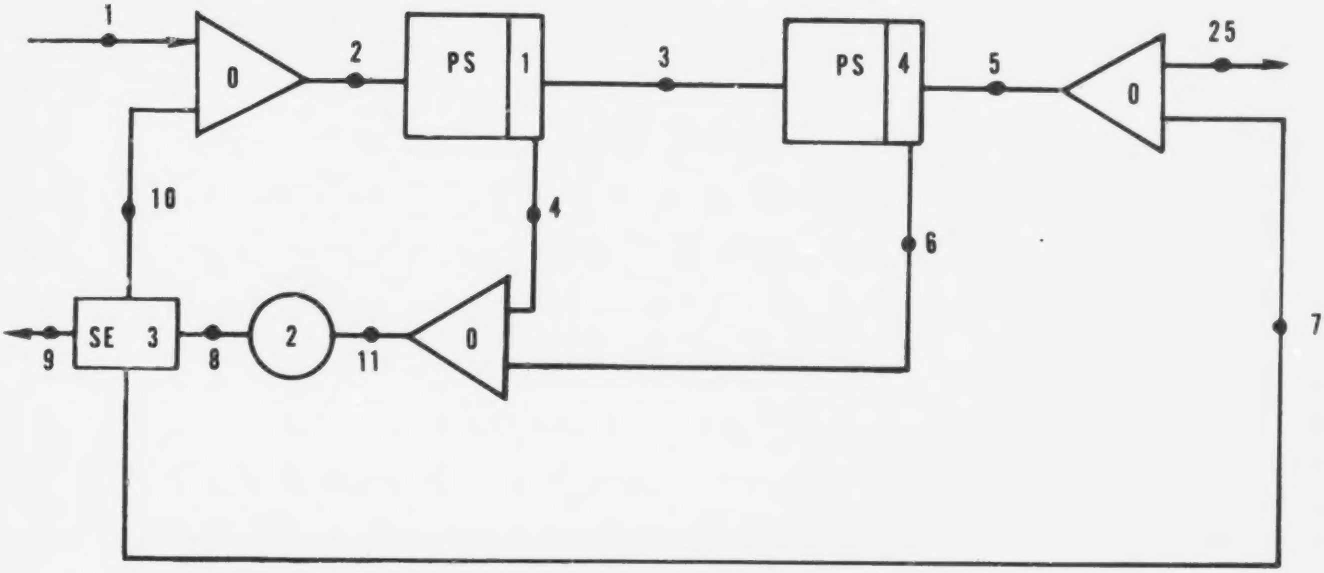
OS2
Fluidized Bed Incineration
IS1
OS1
Single Stage Lime Clarification
Ammonia Stripping and Cooling Towers
Recarbonation Using CO2
IS1
OS2
Granular Carbon Adsorption
IS2
OS1
OS2
IS1
OS1
Microscreening
IS1
OS2
IS2
OS1
Rough Filtration
IS1
OS1
OS2
Electrodialysis
IS1
Reverse Osmosis
OS1
OS2
IS1
OS2
IS2
OS1
Multi- Media Filtration
IS1
OS2
Disinfection
IS2
OS1
Ion Exchange

FIGURE 4

EXAMPLE PROCESS DIAGRAMS DIAGRAMS


1
PT
7
3
0
20
PS
1
2
2
5
0
24
8
25
9
7
0
10
0
8
21
0
11
3
16
14
6
15
SE
5
13
4
12
18
17
9
19
23

System No. 1


1
0
2
PS
1
3
PS
4
5
0
25
10
4
6
9
SE
3
8
2
11
0
7

System No. 2

is described by the stream number in the first row of SMATX, the volume flow in million of gallons per day in the second row, and the concentration of 15 contaminants in rows 3-17. Note that the number of contaminants contained in the stream vector will increase as new process subroutines are added to the program. A list of information contained in the stream vector is shown in TABLE 1 with the FORTRAN variable names used.

A decision matrix (DMATX) is provided with 16 rows and 20 columns for storing design parameters such as overflow rates, solids loading rates, or operating mode decisions, such as mixed liquor suspended solids concentration in the aerator or the BOD to be achieved in the principal effluent stream. Decision parameters for the Nth process are stored in the Nth column of DMATX. Column 20 of DMATX is reserved for cost parameters which apply to all processes. Row 16 (or additional rows if required, such as in the AERFS process) of DMATX is reserved for the excess capacity factor (ECF) which is a multiplier on the size of the process to allow for shutdown for cleaning and maintenance. A list of the contents of DMATX is shown in TABLE 2. For processes having a non-zero process number (N), the contents of the Nth column of DMATX are read into the program from 2 cards which follow the process card for the Nth process. For the mixer and splitter no process number is assigned, or the number zero is given, and the 2 cards containing decision parameters are omitted for these processes.

An output matrix (OMATX) is provided with 20 rows and 20 columns for storing computed output parameters (to be later printed out) from the various process subroutines. Output parameters for the Nth process

TABLE 1

CONTENTS OF STREAM MATRIX (SMATX)

(I designates the stream number)

Row No.	Descriptive Parameters	FORTRAN Variable Names
1	Stream Number	SMATX(1,I), I
2	Volume Flow, mgd	SMATX(2,I), Q
3	Solid Organic Carbon, mg/l	SMATX(3,I), SOC
4	Solid Nonbiodegradable Carbon, mg/l	SMATX(4,I), SNBC
5	Solid Organic Nitrogen, mg/l	SMATX(5,I), SON
6	Solid Organic Phosphorus, mg/l	SMATX(6,I), SOP
7	Solid Fixed Matter, mg/l	SMATX(7,I), SFM
8	Solid BOD, mg/l	SMATX(8,I), SBOD
9	Volatile Suspended Solids, mg/l	SMATX(9,I), VSS
10	Total Suspended Solids, mg/l	SMATX(10,I), TSS
11	Dissolved Organic Carbon, mg/l	SMATX(11,I), DOC
12	Dissolved Nonbiodegradable Carbon, mg/l	SMATX(12,I), DNBC
13	Dissolved Nitrogen, mg/l	SMATX(13,I), DN
14	Dissolved Phosphorus, mg/l	SMATX(14,I), DP
15	Dissolved Fixed Matter, mg/l	SMATX(15,I), DFM
16	Alkalinity, mg/l	SMATX(16,I), ALK
17	Dissolved BOD, mg/l	SMATX(17,I), DBOD
18	Unassigned	
19	Unassigned	
20	Unassigned	

TABLE 2

CONTENTS OF DECISION MATRIX (DMATX)

(N designates the process number)

Aerator-Final Settler

DMATX(1,N) = BOD of OS1
DMATX(2,N) = XMLSS
DMATX(3,N) = DEGC
DMATX(4,N) = CAER20
DMATX(5,N) = DO
DMATX(6,N) = AEFF20
DMATX(7,N) = URSS
DMATX(8,N) = GSS
DMATX(13,N) = ECF (Final Settler)
DMATX(14,N) = ECF (Sludge Return Pump)
DMATX(15,N) = ECF (Blowers)
DMATX(16,N) = ECF (Aerator)

Thickener

DMATX(1,N) = TRR
DMATX(2,N) = TSS of OS1
DMATX(3,N) = GTH
DMATX(4,N) = GSTH
DMATX(16,N) = ECF

Vacuum Filtration

DMATX(1,N) = VFL
DMATX(2,N) = TVF
DMATX(3,N) = TSS
DMATX(16,N) = ECF

Sludge Drying Beds

DMATX(1,N) = SBL
DMATX(16,N) = ECF

Preliminary Treatment

DMATX(16,N) = ECF

Chlorination

DMATX(1,N) = DCL2
DMATX(2,N) = TCL2
DMATX(16,N) = ECF

Primary Settler

DMATX(1,N) = FRPS
DMATX(2,N) = URPS
DMATX(16,N) = ECF

Digester

DMATX(1,N) = TD
DMATX(2,N) = TDIG
DMATX(16,N) = ECF

Elutriation

DMATX(1,N) = ERR
DMATX(2,N) = TSS of OS1
DMATX(3,N) = WRE
DMATX(4,N) = GE
DMATX(5,N) = GES
DMATX(16,N) = ECF

Cost Constants

DMATX(1,20) = CKWH
DMATX(2,20) = CCI
DMATX(3,20) = AF
DMATX(4,20) = CTRP
DMATX(5,20) = CTGO
DMATX(6,20) = CLAND
DMATX(7,20) = CFECL3
DMATX(8,20) = CCL2

Trickling Filter-Final Settler

DMATX(1,N) = BOD of OS1
DMATX(2,N) = DEGC
DMATX(3,N) = HQ
DMATX(4,N) = SAREA
DMATX(5,N) = URSS
DMATX(6,N) = XRSS
DMATX(7,N) = RECYCL
DMATX(8,N) = GSS
DMATX(14,N) = ECF (Pumps)
DMATX(15,N) = ECF (Final Settler)
DMATX(16,N) = ECF (Filter)

are stored in the Nth column of OMATX. Column 20 of OMATX is reserved for output cost parameters which apply to all processes. A list of the contents of OMATX is shown in TABLE 3.

The calling or main program is entitled MAIN and has the function of calling the process subroutines for computing the performance and cost of individual processes in the proper order. When recycle loops occur, this involves recomputing all of the processes within the recycle loop in an iterative manner until each element of all stream vectors involved ceases to vary by more than the prescribed tolerance (EPS).

A description of the system configuration, that is, the processes to be used and the location of the interconnecting streams is communicated to the computer by an input deck of process cards. One card is used for each process. The process number (N) is punched in columns 3 and 4 as shown on the sample coding forms in the APPENDIX. The type of process is specified by an assigned identification number. The process subroutine names and identification numbers are listed below:

SUBROUTINE NAME	IDENTIFICATION NUMBER
PREL	1
PRSET	2
AERFS	3
MIX	4
SPLIT	5
DIG	6
VACF	7
THICK	8
ELUT	9
SBEDS	10
TRFS	11
CHLOR	12

TABLE 3

CONTENTS OF OUTPUT MATRIX (OMATX)

(N designates the process number)

Aerator-Final Settler

OMATX(1,N) = BOD2
OMATX(2,N) = DOSAT
OMATX(3,N) = XRSS
OMATX(4,N) = AFS
OMATX(5,N) = CAER
OMATX(6,N) = CEDR
OMATX(7,N) = VAER
OMATX(8,N) = VNIT
OMATX(9,N) = XMLAS
OMATX(10,N) = XMLBS
OMATX(11,N) = XMLNB
OMATX(12,N) = XMLDS
OMATX(13,N) = XMLIS
OMATX(14,N) = FOOD
OMATX(15,N) = RTURN
OMATX(16,N) = CNIT
OMATX(17,N) = CKWH
OMATX(18,N) = ARCFD
OMATX(19,N) = BSIZE
OMATX(20,N) = CFPGL

Primary Settler

OMATX(1,N) = GPS
OMATX(2,N) = APS

Thickener

OMATX(1,N) = ATHM

Digester

OMATX(1,N) = C1DIG
OMATX(2,N) = C2DIG
OMATX(3,N) = VDIG
OMATX(4,N) = CH4
OMATX(5,N) = CO2

Vacuum Filter

OMATX(1,N) = CFCL3
OMATX(2,N) = FECL3
OMATX(3,N) = WP
OMATX(4,N) = AVF
OMATX(5,N) = CCHEM

Elutriation

OMATX(1,N) = AE

Sludge Drying Beds

OMATX(1,N) = ASB

Trickling Filter-Final Settler

OMATX(1,N) = AFS
OMATX(2,N) = VOL
OMATX(3,N) = FAREA
OMATX(4,N) = DEPTH

Chlorination

OMATX(1,N) = CCL2

Cost

OMATX(1,20) = CENG
OMATX(2,20) = CCR
OMATX(3,20) = TCAP
OMATX(4,20) = TAMM
OMATX(5,20) = TOPER
OMATX(6,20) = TOTAL

The identification number of the type of process is punched in columns 7 and 8 of the process card. If desired, the process subroutine name can be punched in columns 10-16 in order to clearly identify the process card and to include this information in the final program printout. The number of the principal input stream to the process (IS1) is punched in columns 20 and 21. If a second input stream exists, the number of the stream (IS2) is punched in columns 30 and 31. The principal output stream from the process (OS1) is punched in columns 40 and 41. If a second output stream exists, the number (OS2) is punched in columns 50 and 51. Notice that the principal input and output streams must correspond to the designation shown in FIGURES 1 to 3.

The order in which the processes are computed is determined by the integer (K) punched in column 1 and the integer (III) punched in column 80. K is the recycle loop number and it can be assigned any number from 1 to 9. Note that when K is set equal to 9, this signifies an end-of-file for input to a particular case. The first and last processes to be computed in a recycle loop are marked with the same loop number (K) in column 1. Recycle loops within recycle loops are allowed, but each loop must be assigned a unique loop number.

The integer (III) is used to identify primary loops, that is, loops which are not inside of any other loop. The first and last process of primary loops are marked by the integer (1) in column 80, all the other processes within the primary loop have the integer (0) punched in column 80. Processes which are not part of any recycle loop are marked with the integer (2) in column 80.

A list of the process cards are printed as part of the output format of the program. The process cards for the two systems shown in FIGURE 4 are listed in TABLE 4.

TABLE 4

INPUT DATA System No. 1

K	N	PROCESS	IS1	IS2	OS1	OS2	III
0	7	1 PREL	1	0	3	0	2
1	0	4 MIX	3	9	20	0	1
0	1	2 PRSET	20	0	2	8	0
0	2	3 AERFS	2	0	5	7	0
0	0	5 SPLIT	5	0	24	17	0
0	0	4 MIX	7	8	10	0	0
0	3	8 THICK	10	0	12	11	0
0	4	6 DIG	12	0	13	0	0
0	5	9 ELUT	13	17	15	14	0
0	6	7 VACF	15	0	18	16	0
0	0	4 MIX	11	14	21	0	0
1	0	4 MIX	16	21	9	0	1
0	8	12 CHLOR	24	0	25	0	2
0	9	10 SBEDS	18	0	19	0	2
9	0	0	0	0	0	0	0

INPUT DATA System No. 2

K	N	PROCESS	IS1	IS2	OS1	OS2	III
1	0	4 MIX	1	10	2	0	1
2	0	4 MIX	1	10	2	0	0
0	1	2 PRSET	2	0	3	4	0
0	0	4 MIX	4	6	11	0	0
0	2	6 DIG	11	0	8	0	0
2	3	9 ELUT	8	7	9	10	0
0	0	5 SPLIT	5	0	25	7	0
1	4	2 PRSET	3	0	5	6	1
9	0	0	0	0	0	0	0

USE OF CODING FORMS

Two coding forms have been developed for preparing input data to the program. These are found in FIGURE V of the APPENDIX. SHEET 1 contains the description of the influent and guess streams. The number of streams read in cannot exceed ten. The number of input streams (NIS) to be read is punched in the first four columns of the first input card. The stream numbers are then read in (in the order that they will appear) as elements of the NN vector. The flow and concentrations of the first, second, third, etc., streams are then read in using F10.3 fields. The tolerance (EPS) to be used for recycle iteration is read in with a F10.3 field on the first card.

The next group of data to be read in on SHEET 1 contains general cost information. These data are read into column 20 of the decision matrix (DMATX). Definitions of these terms can be found in FIGURE II of the APPENDIX.

Process cards are prepared next on SHEET 2 with the two decision cards following each process card unless the process number is zero. The parameters shown on the decision cards will correspond to the process specified on the process card; see TABLE 2. After one process card and two decision cards (where necessary) have been prepared for each process in the system and they have been arranged in the correct order, the input deck is terminated with a card in which a (9) has been punched in the first column. This card is important because it indicates end-of-file.

PRINTED OUTPUT FORMAT

Sample output from the program is given in FIGURE IV of the APPENDIX. The first group of output printing shows the process cards which describe the wastewater treatment system which was simulated. The second group of data shows the volume flow and concentrations of 15 contaminants in each numbered stream. The stream is identified by the letter (S) followed by the stream number in the left-hand column of the printout. For example, stream number 3 is identified by (S 3).

The third set of output lists the processes according to process number and gives the name of the process with all pertinent parameters relating to the process. The process is identified by the letter (P) followed by the process number in the left-hand column of the printout. For example, process number 3 is identified by (P 3). The capital cost for the process is given in thousands of dollars. The operating and maintenance cost, the amortization cost, and the total treatment cost are given for each process in cents per thousand gallons of water treated. The flow used here is always that of the influent stream designated as stream number 1. The fourth set of printout shows the general cost items, such as the capital cost index (CCI), the amortization factor (AF), the cost of engineering (CENG), contractor's profit (CTRP), contingencies and omissions (CTGO), and land (CLAND). The total capital cost of the entire system is given in thousands of dollars. The total amortization cost, total operating and maintenance cost, and total treatment cost for the system are given in cents per 1000 gallons of water treated.

Detailed discussion of individual process models can be found in the following FWQA Report No. WP-20-9:

Preliminary Design and Simulation of Conventional Wastewater Renovation Systems Using the Digital Computer
by
Robert Smith

The trickling filter model is fully described in the following FWQA Report No. W69-2:

A Mathematical Model for a Trickling Filter
by
Joseph F. Roesler
Robert Smith

APPENDIX

INPUT DATA FOR THE EXECUTIVE PROGRAM

Input Card 1: FORMAT(I2)
NCASE

Input Card 2: FORMAT(11I4,6X,F10.3)
NIS,(NN(I),I=1,10),EPS

Input Cards 3, 4 (or more): FORMAT(8F10.3/8F10.3)
(SMATX(I,NN(1)),I=2,17)

Input Cards 5, 6, 7: FORMAT(8F10.3/8F10.3)
(DMATX(I,20),I=1,16)

Input Card 8: FORMAT(I1,1X,I2,2X,I2,1X,3A2,4X,I2,8X,I2,8X,I2,8X,I2,
28X,I1)
K,N,IPROC,(NAME(I),I=1,3),IS1,IS2,OS1,OS2,III

Input Cards 9, 10, 11: FORMAT(8F10.3/8F10.3)
(DMATX(I,N),I=1,16)

Input Cards 12 and on: Continue with additional process cards.
Process card with a (9) punched in column (1) will indicate end of case.
Begin next data case with Input Card 2, etc.

FIGURE I	gives the card input for the two sample systems of FIGURE 4 in the text.
FIGURE II	gives the definitions of the FORTRAN variables used by the EXECUTIVE program.
FIGURE III	gives the entire FORTRAN listing of the EXECUTIVE program.
FIGURE IV	gives the program printout for System No. 1 of FIGURE 4 in the text.
FIGURE V	gives the two coding forms that can be used to prepare input for the EXECUTIVE program.

FIGURE I

```
9                                                                                      1.

   4.4
0  9  10 SBEDS      13          0          19         0                                 2
                                                                                       1.

     3.      30.
0  3  13 CHLOR      24          0          25         0                                 2
1  0   4 MIX        14         21           9         0                                 1
0  0   4 MIX        11         14          21         0                                 0
                                                                                   1.0

    4.5         .238    200.
0  3   7 VACF       15          0          15        16                                 0
                                                                                   1.5

     .75  60000.         3.0      500.         9.0
0  5   9 ELUT       13         17          15        14                                 0
                                                                                   2.0

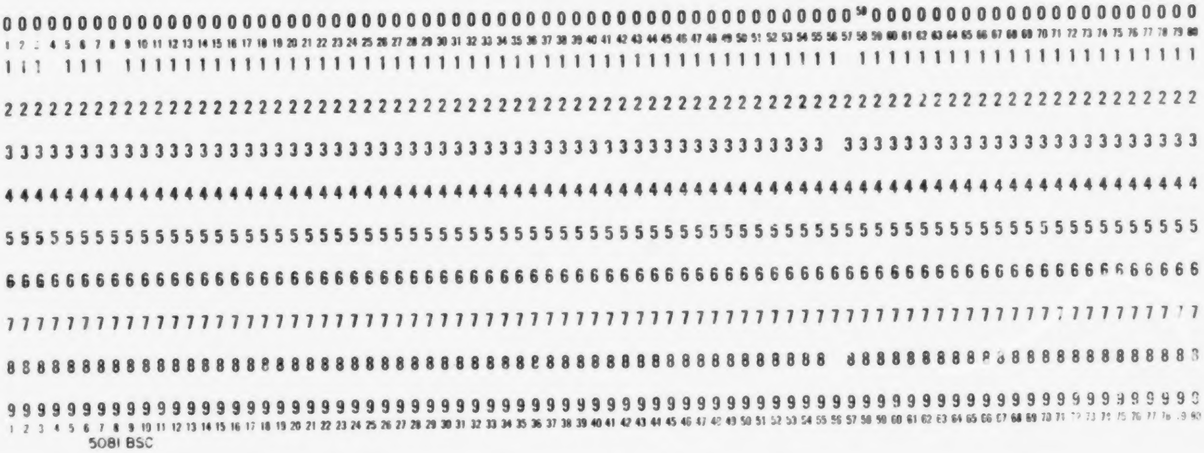
   10.0       33.0
0  4   6 DIG        12          0          13         0                                 0
                                                                                   1.5

      .55  60000.       750.          9.0
0  3   5 THICK      10          0          12        11                                 0
0  0   4 MIX         7          3          10         0                                 0
0  0   3 SPLIT       5          0          24        17                                 0
                                                    2.0        2.0        1.5        1.2
    13.0    3000.         30.        1.0        1.0        .05        3.0     2000.
0  2   3 HIRFS       3          0           5         7                                 0
                                                                                   2.0

      .5      400.
0  1   2 RKSET      20          0           2         5                                 0
1  0   4 MIX         3          3          20         0                                 1
                                                                                   1.0

      0.
0  7   1 PREL        1          0           3         0                                 6
      0.
     .01        1.15        .067         .1        .15        .02        .08        .08
   259.6        43.0        11.0       19.1        4.0      500.0      250.0      59.54
    10.0       105.0        30.0       10.0        2.0       30.0      140.8      223.6
   1   1                                                      .10
```

System No. 1



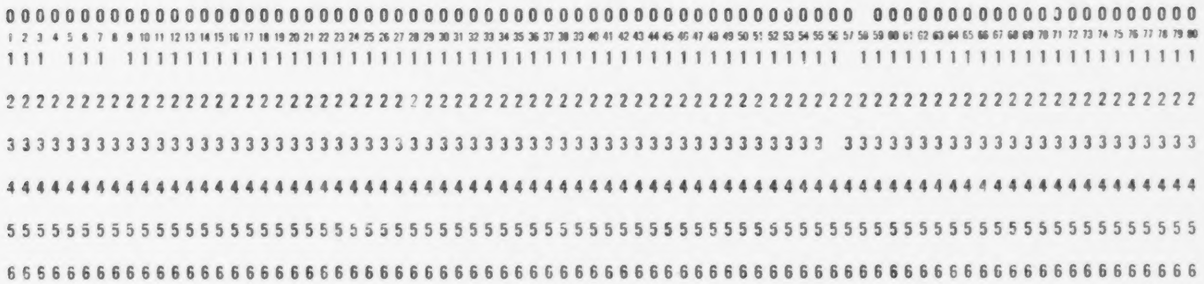
```
9  0   0             0 .      0        0        0                       0
                                                                     2.0

     .5     400.
1  4   2 PRSET       3        0        5        2                       1
0  3   5 SPLIT       5        0       25        7                       0
                                                                     1.0
     .75  60000.       3.0     300.       9.0
2  3   3 ELUT        5        7        9       10                       0
                                                                     2.0

   15.0       33.0
0  2   5 DIG        11        6        9        0                       0
0  0   1 MIX         4        6       11        0                       0
                                                                     2.0

     .5     400.
0  1   2 PRSET       2        3        3        4                       0
5  0   4 MIX         1       10        2        0                       0
1  0   4 MIX         1       10        2        0                       1
     0.
     .01      1.13       .067       .1        .15       .02       .03      .08
   253.6      43.0       11.0      19.1       4.0     500.0     850.0    59.51
    10.0     105.0       30.0      10.0       2.0      30.0     140.1    223.5
   1  1                                                .10
```

System No. 2



```
                                                        2.        5.       1.2
     26.4       20.       10.       10.       1.       .6        1.     2000.
0  5  11 TRFS        2        0        5        7                          0
```

Sample Trickling Filter Input Which
Could be Used to Replace the Aeration
Process in System No. 1

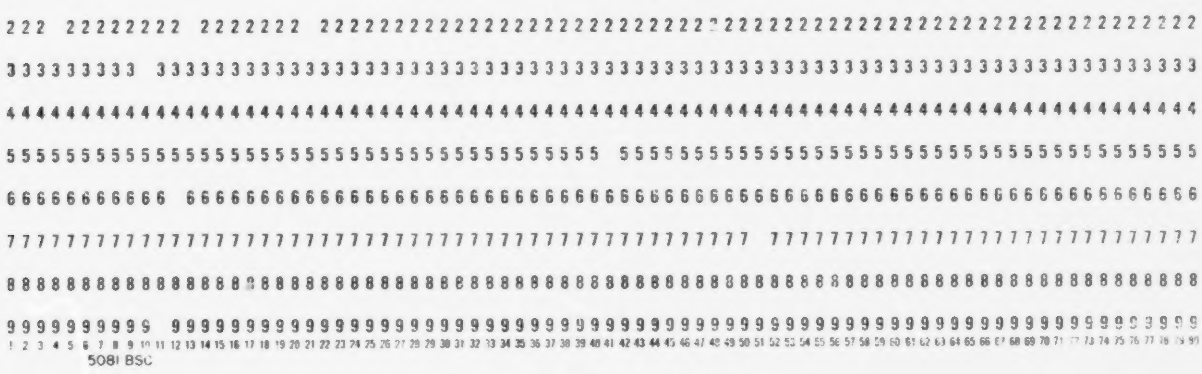


FIGURE II

DEFINITIONS OF FORTRAN SYMBOLS

Computer Symbol	Definitions and Comments
ACOST(I,J)	Amortization cost for the Ith process, cents per 1000 gallons
AE	Surface area of the elutriation tank, sq ft
AEFF20	Efficiency of diffuser in aerator at zero dissolved oxygen and 20°C
AF	Amortization factor
AFS	Surface area of the final settler, sq ft/1000
ARCFD	Air requirements for the aerator, scf/day
ALK	Concentration of alkalinity as $CaCO_3$, mg/l
APS	Surface area of the primary settler, sq ft/1000
ASB	Area of the sludge drying beds, sq ft
ATHM	Greater of the surface area of the thickener based on overflow rate or on solids loading rate, sq ft
AVF	Area of the vacuum filter, sq ft
BOD	Input value for the demand value of 5-day BOD in the final effluent from the aeration or trickling filter process, mg/l
BOD2	Influent 5-day BOD to the aeration process, mg/l
BSIZE	Required size of blower for supplying air to the aerator, cubic feet per minute
C1DIG	Rate constant for digester
C2DIG	Rate constant for digester
CAER	Rate constant for sizing the aerator corrected for water temperature
CAER20	Rate constant used for sizing the aerator when water temperature is 20°C

Computer Symbol	Definitions and Comments
CCHEM	Cost of ferric chloride, dollars per year
CCI	Capital cost index to account for the variation of construction cost with time
CCL2	Cost of chlorine, dollars per pound
CCOST(I,J)	Capital cost for the Ith process, thousands of dollars
CCR	Capital cost ratio: CCR = 1 + CENG + CTRP + CLAND + CTGO
CEDR	Rate at which active solids are destroyed by natural causes in the aerator, fraction per day mass
CENG	Cost of engineering services expressed as a fraction of the total capital cost
CFECL3	Cost of ferric chloride, cents per pound
CRPGL	Air requirement for the aerator, scf/gallon of sewage entering the system
CH4	Standard cubic feet of methane produced in the digester each day, scf/day methane
CKWH	Cost of electrical power, dollars per kilowatt-hour
CLAND	Cost of land expressed as a fraction of the total capital cost
CNIT	Rate constant used in the nitrification calculation
CO2	Standard cubic feet of carbon dioxide produced in the digester each day, scf/day CO_2
COSTO(I,J)	Operating and maintenance cost for the Ith process, cents per 1000 gallons
CTGO	Cost of contingencies and omissions expressed as a fraction of the total capital cost
CTRP	Contractor's profit expressed as a fraction of the total capital cost

Computer Symbol	Definitions and Comments
DBOD	Dissolved BOD concentration, mg/l
DCL2	Dose of chlorine, mg/l
DEGC	Water temperature, degrees centigrade
DEPTH	Depth of the trickling filter, feet
DFM	Dissolved inorganic species, mg/l
DMATX(I,J)	Decision matrix vector for the Jth process
DN	Dissolved nitrogen concentration, mg/l nitrogen
DNBC	Dissolved non-biodegradable carbon concentration, mg/l carbon
DO	Concentration of dissolved oxygen in the aerator, mg/l oxygen
DOC	Dissolved organic carbon concentration, mg/l carbon
DOSAT	Saturation value for dissolved oxygen in the aerator at one-half the water depth, mg/l oxygen
DP	Dissolved phosphorus concentration, mg/l phosphorus
ECF	Excess capacity factor
EPS	Iteration tolerance for recycling systems
ERR	Solids recovery ratio for elutriation
FAERA	Area of the face of the filter, sq ft
FECL3	Concentration of ferric chloride used for sludge conditioning, mg/l $FeCL_3$
FOOD	5-day BOD synthesized to active solids in the aerator each day, mg/l oxygen
FRPS	Fraction of solids entering the primary settler which is removed from the main stream and sent to the thickener

Computer Symbol	Definitions and Comments
GE	Design overflow rate for elutriation, gallons per day per sq ft
GES	Design solids loading rate for elutriation, lb/day/sq ft
GPS	Computed overflow rate for the primary settler, gpd/sq ft
GSS	Design overflow rate for the final settler, gpd/sq ft
GSTH	Design solids loading rate for the thickener, lb/day/sq ft
GTH	Design overflow rate for the thickener, gpd/sq ft
HQ	Trickling filter hydraulic loading, mgd/acre
III	Integer input to the program that controls the recycling in the system
IPROC	Integer input to the program that is used to identify the type of process
IS1	Input stream number 1 to a process
IS2	Input stream number 2 to a process
K	Integer input to the program that controls the recycling in the system
N	Process number assigned to a particular process in the system by the program user
NAME(I)	Integer input vector that is used to print process names as part of the final output
NCASE	Integer input to the program that specifies the number of cases to be executed by the program
NIS	Integer input to the program that specifies the number of influent and guess streams to be read by the program

Computer Symbol	Definitions and Comments
NN(I)	Integer inputs to the program that specify the stream numbers of the influent and guess streams to be read by the program
OMATX(I,J)	Output matrix vector for the Jth process
OS1	Output stream number 1 from a process
OS2	Output stream number 2 from a process
Q	Volume flow, mgd
RECYCL	Trickling filter recirculation number
RTURN	Sludge return ratio for the aerator
SAREA	Trickling filter specific surface area, feet squared per feet cubed
SBOD	Solid 5-day BOD concentration, mg/l oxygen
SBL	Sludge bed loading, pounds of solids/ft^2 of bed area/month
SFM	Solid inorganic matter concentration, mg/l mass
SMATX(I,J)	Stream matrix vector for the Jth stream
SNBC	Solid non-biodegradable carbon concentration, mg/l carbon
SOC	Solid carbon concentration, mg/l carbon
SON	Solid nitrogen concentration, mg/l nitrogen
SOP	Solid phosphorus concentration, mg/l phosphorus
TAMM	Total amortization cost for the entire system, cents per 1000 gallons
TCAP	Total capital cost for the entire system, thousands of dollars
TCL2	Chlorine contact time, minutes
TCOST(I,J)	Total treatment cost for the Ith process, cents per 1000 gallons

Computer Symbol	Definitions and Comments
TD	Digester detention time, days
TDIG	Sludge temperature in digester, degrees centigrade
TMATX(I,J)	Temporary stream matrix vector for the Jth stream that is used internally by the program for the recycling iteration
TOPER	Total operating and maintenance cost for the entire system, cents per 1000 gallons
TOTAL	Total treatment cost for the entire system, cents per 1000 gallons
TRR	Solids recovery ratio for thickening
TSS	Total suspended solids concentration, mg/l mass
TVF	Fraction of the time vacuum filters are operated
URPS	Ratio of solids concentration in OS2 from the primary settler to the solids concentration in IS1 to the primary settler
URSS	Ratio of solids concentration in OS2 (underflow stream) from the aerator-final settler to the total solids concentration in the aerator
VAER	Volume of the aerator, millions of gallons
VDIG	Volume of the digester, cubic feet/1000
VFL	Vacuum filter loading, gallons per hour per sq ft
VOL	Trickling filter total volume, cubic feet
VNIT	Volume of the aerator required to achieve nitrification, millions of gallons
VSS	Volatile suspended solids concentration, mg/l mass
WP	Percentage of moisture in the filtered sludge

Computer Symbol	Definitions and Comments
WRE	Wash water ratio for elutriation
XMLAS (MLASS)	Concentration of active solids held in the aerator, mg/l mass
XMLBS (MLBSS)	Concentration of unmetabolized biodegradable solids held in the aerator, mg/l mass
XMLDS (MLDSS)	Concentration of non-biodegradable solids in the aerator caused by destruction of active solids by natural causes, mg/l mass
XMLIS (MLISS)	Concentration of inert inorganic solids in the aerator caused by inorganic solids in the influent stream, mg/l mass
XMLNB (MLNBSS)	Concentration of non-biodegradable organic solids in the aerator, mg/l mass
XMLSS (MLSS)	Total concentration of solids in the aerator, mg/l mass
XRSS	Ratio of solids concentration of OS1 (overflow stream from the aerator-final settler to the total solids concentration in the aerator

mgd = millions of gallons per day
mg/l = milligrams per liter
scf = standard cubic feet
gpd = gallons per day

FIGURE III

EXECUTIVE PROGRAM FOR PRELIMINARY DESIGN

```
      INTEGER OS1,OS2
      DIMENSION IFAIL(10),LOOP(10),NN(10),NAME(3)
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      DEFINE FILE 10 (50,15,U,NNNNN)
      INP=2
      IO=5
      READ(INP,1) NCASE
    1 FORMAT(I2)
      DO 1120 IJ=1,NCASE
      DO 5 I=1,20
      DO 5 J=1,25
      SMATX(I,J)=0.
    5 TMATX(I,J)=0.
      DO 10 I=1,20
      DO 10 J=1,20
      DMATX(I,J)=0.
   10 OMATX(I,J)=0.
      DO 15 I=1,20
      DO 15 J=1,5
      CCOST(I,J)=0.
      COSTO(I,J)=0.
      ACOST(I,J)=0.
   15 TCOST(I,J)=0.
      DO 16 I=1,25
   16 IP(I)=0
      DO 17 I=1,10
      IFAIL(I)=0
      LOOP(I)=0
   17 NN(I)=0
      IAERF=0
      KKK=1
      READ(INP,20) NIS,(NN(I),I=1,10),EPS
   20 FORMAT(11I4,5X,F10.3)
      DO 40 J=1,NIS
      LL=NN(J)
   40 READ(INP,60) (SMATX(I,LL),I=2,17)
   60 FORMAT(8F10.3/8F10.3)
      READ(INP,60) (DMATX(I,20),I=1,16)
      WRITE(IO,80)
   80 FORMAT(1H1,////,55X,'INPUT DATA',//,25X,'K',5X,'N',5X,'PROCESS',
     . 9X,'IS1',7X,'IS2',7X,'OS1',7X,'OS2',7X,'III',//)
  100 READ(INP,120) K,N,IPROC,(NAME(I),I=1,3),IS1,IS2,OS1,OS2,III
  120 FORMAT(I1,1X,I2,2X,I2,1X,3A2,4X,I2,8X,I2,8X,I2,8X,I2,28X,I1)
      WRITE(IO,140) K,N,IPROC,(NAME(I),I=1,3),IS1,IS2,OS1,OS2,III
  140 FORMAT(25X,I1,4X,I2,4X,I2,2X,3A2,7X,I2,8X,I2,8X,I2,8X,I2,8X,I2)
      IF(K-9) 160,280,160
  160 SMATX(1,IS1)=IS1
      SMATX(1,OS1)=OS1
      IF(IS2) 180,200,180
  180 SMATX(1,IS2)=IS2
  200 IF(OS2) 220,240,220
  220 SMATX(1,OS2)=OS2
  240 IF(N) 260,280,260
  260 IP(N)=IPROC
      READ(INP,60) (DMATX(I,N),I=1,16)
```

```
280 WRITE(10'KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
    KKK=KKK+1
    IF(K-9) 100,300,100
300 KKK=1
    K=0
    INDC=0
    IN=1
320 IFLUK=0
340 IFAIL(IN)=0
    KOUT=0
360 READ(10'KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
    KKK=KKK+1
    IF(K-9) 380,1110,380
380 IF(K) 390,420,390
390 IF(INDC) 420,400,420
400 INDC=K
420 IF(K) 440,500,440
440 IF(K-INDC) 460,500,460
460 LOOP(IN)=INDC
    IN=IN+1
    INDC=K
    KOUT=0
    IF(IFLUK-1) 480,500,480
480 IFLUK=IFAIL(IN-1)
500 IF(K-INDC) 540,520,540
520 KOUT=KOUT+1
540 GO TO (550,560,570,590,600,610,620,630,640,650,660,670),IPROC
550 CALL PREL
    GO TC 700
560 CALL PRSET
    GO TO 700
570 CALL AERFS
    IF(IAERF) 1120,580,1120
580 GO TO 700
590 CALL MIX
    GO TO 700
600 CALL SPLIT
    GO TO 700
610 CALL DIG
    GO TO 700
620 CALL VACF
    GO TO 700
630 CALL THICK
    GO TO 700
640 CALL ELUT
    GO TO 700
650 CALL SBEDS
    GO TO 700
660 CALL TRFS
    GO TO 700
670 CALL CHLOR
700 IF(III-2) 720,340,720
720 DC 740 I=2,17
    IF(ABS(SMATX(I,OS1)-TMATX(I,OS1))-EPS) 740,740,800
740 CONTINUE
    IF(OS2) 760,820,760
760 DC 780 I=2,17
```

```
      IF(ABS(SMATX(I,OS2)-TMATX(I,OS2))-EPS) 780,780,800
  780 CONTINUE
      GO TO 820
  800 IFAIL(IN)=1
  820 DO 840 I=1,20
  840 TMATX(I,OS1)=SMATX(I,OS1)
      IF(OS2) 860,900,860
  860 DO 880 I=1,20
  880 TMATX(I,OS2)=SMATX(I,OS2)
  900 IF(KOUT-2) 360,920,360
  920 IF(IFAIL(IN)) 980,940,980
  940 IF(IFLUK) 980,960,980
  960 IF(III-1) 980,1080,980
  980 IF(IFAIL(IN)) 1000,1060,1000
 1000 KKK=1
 1020 READ(10'KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
      KKK=KKK+1
      IF(K-INDC) 1020,1040,1020
 1040 KKK=KKK-1
      IF(III-1) 340,320,340
 1060 INDC=LOOP(IN-1)
      KOUT=1
      IN=IN-1
      GO TO 360
 1080 INDC=0
      GO TO 320
 1110 CALL COST
      CALL PRINT
 1120 CONTINUE
      CALL EXIT
      END
```

PRELIMINARY TREATMENT

```
      SUBROUTINE PREL
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      DO 10 I=2,17
   10 SMATX(I,OS1)=SMATX(I,IS1)
      Q1=SMATX(2,IS1)*DMATX(16,N)
      CCOST(N,1)=14.7*Q1**.625
      COSTO(N,1)=.5*Q1+2.15*Q1**.37
      RETURN
      END
```

PRIMARY SETTLER

```
      SUBROUTINE PRSET
      INTEGER OS1,CS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      SMATX(2,OS2)=DMATX(1,N)*SMATX(2,IS1)/DMATX(2,N)
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      TEMP1=(1.-DMATX(1,N))*SMATX(2,IS1)/SMATX(2,OS1)
      TEMP2=DMATX(1,N)*SMATX(2,IS1)/SMATX(2,OS2)
      DO 10 I=3,10
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS2)=SMATX(I,IS1)
   20 SMATX(I,OS1)=SMATX(I,OS2)
      GPS=-2780.*ALOG(DMATX(1,N))-551.7
      APS=SMATX(2,IS1)*1000./GPS*DMATX(16,N)
      CCOST(N,1)=13.4*APS+5.2*APS**.1
      COSTO(N,1)=APS+2.5*APS**.5
      OMATX(1,N)=GPS
      CMATX(2,N)=APS
      RETURN
      END
```

AERATOR - FINAL SETTLER

```
      SUBROUTINE AERFS
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTC(20,5),
     . ACOST(20,5),TCOST(20,5)
      BOD2=SMATX(8,IS1)+SMATX(17,IS1)
      DBOD2=SMATX(17,IS1)
      CEDR=.18*1.047**(DMATX(3,N)-28.)
      CAER=DMATX(4,N)*1.047**(DMATX(3,N)-20.)
      SA=DMATX(2,N)/1000.
      TA=(BOD2-DMATX(1,N))/(DMATX(1,N)*CAER*SA*24.)
      VAER=SMATX(2,IS1)*TA
      XRSS=556.1*DMATX(8,N)**.4942/DMATX(2,N)**1.8165/(TA*24.)**.4386
      ASMAX=DMATX(1,N)/XRSS/.685
      ASMIN=0.
      IF(ASMAX-DMATX(2,N)) 20,20,10
   10 ASMAX=DMATX(2,N)
   20 XMLAS=(ASMAX+ASMIN)/2.
      FOOD=SMATX(8,IS1)+DBOD2
      FMAX=FOOD
      N1=1
      GO TO 80
   30 ERROR=FMAX-FMIN
      IF(ERROR-.1) 220,220,40
   40 FOOD=(FMAX+FMIN)/2.
   50 IF(FOOD-SMATX(17,IS1)) 60,60,70
   60 DBOD4=SMATX(17,IS1)-FOOD
      SBOD4=SMATX(8,IS1)
      GO TO 80
   70 SBOD4=(SMATX(8,IS1)+SMATX(17,IS1)-FOOD)*.7
      DBOD4=.233*SBOD4
   80 TEMP1=.65*FOOD/XMLAS-XRSS
      SMATX(2,OS2)=(SMATX(2,IS1)*TEMP1-CEDR*VAER)/(DMATX(7,N)-XRSS)
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      N1=N1+1
      IF(N1-2) 100,100,90
   90 TEMP2=XRSS*SMATX(2,OS1)+DMATX(7,N)*SMATX(2,OS2)
      XMLBS=SMATX(2,IS1)*SBOD4/TEMP2/.8
      SMATX(8,OS1)=(XMLAS*.685+XMLBS*.8)*XRSS
      SMATX(17,OS1)=DBOD4
      TBOD5=SMATX(8,OS1)+SMATX(17,OS1)
      GO TO 110
  100 TBOD5=XMLAS*XRSS*.685
  110 IF(TBOD5-DMATX(1,N)) 120,120,170
  120 IF(N1-3) 130,140,160
  130 FMIN=(CEDR*VAER/SMATX(2,IS1)+XRSS)*XMLAS/.65
      FOOD=FMIN
      GO TO 50
  140 WRITE(IO,150)
  150 FORMAT(10X,'DEMAND MLASS CANNOT BE HELD')
      IAERF=1
      GO TO 370
  160 FMAX=FOOD
      GO TO 30
  170 IF(N1-3) 180,210,200
  180 WRITE(IO,190)
  190 FORMAT(10X,'BOD5 DEMAND CANNOT BE ACHIEVED')
```

```
      IAERF=1
      GO TO 370
  200 FMIN=FOOD
  210 GO TO 30
  220 XMLNB=SMATX(4,IS1)*SMATX(2,IS1)*2.13/TEMP2
      XMLIS=SMATX(2,IS1)*SMATX(7,IS1)/TEMP2
      XMLDS=.12*SMATX(2,IS1)*FOOD/TEMP2-.185*XMLAS
      TEMP3=XMLAS+XMLBS+XMLNB+XMLDS+XMLIS
      TEMP4=TEMP3-DMATX(2,N)
      IF(ABS(TEMP4)-5.) 260,260,230
  230 IF(TEMP4) 240,240,250
  240 ASMIN=XMLAS
      GO TO 20
  250 ASMAX=XMLAS
      GO TO 20
  260 SMATX(3,OS1)=(XMLDS+XMLAS)*XRSS/2.46+(XMLBS+XMLNB)*XRSS/2.33
      SMATX(4,OS1)=XMLNB*XRSS/2.33+(XMLDS+.185*XMLAS)*XRSS/2.46
      TEMP5=XRSS*XMLAS/2.46
      SMATX(5,OS1)=.234*TEMP5+(SMATX(3,OS1)-TEMP5)/10.
      SMATX(6,OS1)=SMATX(3,OS1)*.01
      SMATX(7,OS1)=XMLIS*XRSS
      SMATX(9,OS1)=SMATX(3,OS1)*2.38
      SMATX(10,OS1)=SMATX(7,OS1)+SMATX(9,OS1)
      DO 270 I=3,10
  270 SMATX(I,OS2)=SMATX(I,OS1)*DMATX(7,N)/XRSS
      SMATX(11,OS1)=SMATX(12,IS1)+DBOD4/1.87
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(13,OS1)=(SMATX(2,IS1)*(SMATX(5,IS1)+SMATX(13,IS1))-
     . (SMATX(5,OS1)*SMATX(2,OS1)+SMATX(5,OS2)*SMATX(2,OS2)))/
     . (SMATX(2,OS1)+SMATX(2,OS2))
      SMATX(14,OS1)=(SMATX(2,IS1)*(SMATX(6,IS1)+SMATX(14,IS1))-
     . (SMATX(6,OS1)*SMATX(2,OS1)+SMATX(6,OS2)*SMATX(2,OS2)))/
     . (SMATX(2,OS1)+SMATX(2,OS2))
      SMATX(15,OS1)=SMATX(15,IS1)
      DO 280 I=11,15
  280 SMATX(I,OS2)=SMATX(I,OS1)
      Q6=(SMATX(2,IS1)*(1.-.65*FOOD/XMLAS)+CEDR*VAER)/(DMATX(7,N)-1.)
      RTURN=Q6/SMATX(2,IS1)
      X4X3=(1.+RTURN)/RTURN/DMATX(7,N)
      DN3=SMATX(13,IS1)/(1.+RTURN)
      X3Y=DN3*.99/(X4X3-1.)
      CNIT=.18*EXP(.116*(DMATX(3,N)-15.))
      IF(X4X3) 290,290,300
  290 TTAN=0.
      GO TO 310
  300 TTAN=(1.+RTURN)*(ALOG(X4X3)+4.605/(DN3+X3Y))/CNIT
  310 VNIT=SMATX(2,IS1)*TTAN
      IF(VNIT-VAER) 320,320,330
  320 SMATX(16,OS1)=SMATX(16,IS1)+3.57*(SMATX(13,OS1)-SMATX(13,IS1))
      GO TO 340
  330 SMATX(16,OS1)=SMATX(16,IS1)
  340 SMATX(16,OS2)=SMATX(16,OS1)
      SMATX(17,OS2)=SMATX(17,OS1)
      DOSAT=(14.16-.3943*DMATX(3,N)+.007714*DMATX(3,N)**2-.0000646*
     . DMATX(3,N)**3)*1.221
      AEFF=DMATX(6,N)*(DOSAT-DMATX(5,N))*1.02**(DMATX(3,N)-20.)/DOSAT
      WFOOD=SMATX(2,IS1)*FOOD*8.33
      WAS=XMLAS*VAER*8.33
      ARCFD=(.577*WFOOD+1.16*CEDR*WAS)/AEFF/.232/.075
      WDN=(SMATX(2,OS1)*SMATX(13,OS1)+SMATX(2,OS2)*SMATX(13,OS2))*8.33
      IF(VNIT-VAER) 350,350,360
  350 ARCFD=ARCFD+4.6*WDN/AEFF/.232/.075
  360 BSIZE=DMATX(15,N)*ARCFD/1440.
      CFPGL=ARCFD/1000000./SMATX(2,IS1)
      VAER=VAER*DMATX(16,N)
      Q4=Q6+SMATX(2,IS1)
      Q6=Q6*DMATX(14,N)
      AFS=Q4*1000./DMATX(8,N)*DMATX(13,N)
      CAIRP=ARCFD*365.*DMATX(1,20)/1830000.
      CCOST(N,1)=175.*VAER+36.5*VAER**.182
      CCOST(N,2)=10.57+.005857*BSIZE
      CCOST(N,3)=3.65+1.125*Q6
      CCOST(N,4)=12.6*AFS+5.35/AFS**.126
      COSTO(N,1)=10.*VAER+14.5*VAER**.5
      COSTO(N,2)=CAIRP
      COSTO(N,3)=0.
      COSTO(N,4)=0.
      OMATX(1,N)=BOD2
      OMATX(2,N)=DOSAT
      OMATX(3,N)=XRSS
      OMATX(4,N)=AFS
      OMATX(5,N)=CAER
      OMATX(6,N)=CEDR
      OMATX(7,N)=VAER
      OMATX(8,N)=VNIT
      OMATX(9,N)=XMLAS
      OMATX(10,N)=XMLBS
      OMATX(11,N)=XMLNB
      OMATX(12,N)=XMLDS
      OMATX(13,N)=XMLIS
      OMATX(14,N)=FOOD
      OMATX(15,N)=RTURN
      OMATX(16,N)=CNIT
      OMATX(17,N)=DMATX(1,20)
      OMATX(18,N)=ARCFD
      OMATX(19,N)=BSIZE
      OMATX(20,N)=CFPGL
  370 RETURN
      END
```

TRICKLING FILTER - FINAL SETTLER

```
      SUBROUTINE TRFS
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      BODIN=SMATX(8,IS1)+SMATX(17,IS1)
      BETA=.0245*1.035**(DMATX(2,N)-20.)
      XN=.91-6.45/DMATX(4,N)
      FAREA=SMATX(2,IS1)/DMATX(3,N)*43560.
      Q6=DMATX(7,N)*SMATX(2,IS1)
      RHQ=((DMATX(7,N)+1.)*DMATX(3,N))**XN
      BOD=(SMATX(17,IS1)+DMATX(6,N)*SMATX(8,IS1))/DMATX(1,N)
      DEPTH=RHQ*ALOG((BOD+DMATX(7,N))/(DMATX(7,N)+1.))/(BETA*DMATX(4,N))
      XPO=EXP(BETA*DMATX(4,N)*DEPTH/RHQ)
      BODO=BODIN/(XPO*(DMATX(7,N)*(1.-1./XPO)+1.))
      DBODO=SMATX(17,IS1)/(XPO*(DMATX(7,N)*(1.-1./XPO)+1.))
      SBOD4=BODO-DBODO
      SBOD5=SBOD4*DMATX(6,N)
      BETAN=.00307*1.141**(DMATX(2,N)-20.)
      XPON=EXP(BETAN*DMATX(4,N)*DEPTH/RHQ)
      SON4=SMATX(5,IS1)*SBOD4/SMATX(8,IS1)
      DN4=(SMATX(13,IS1)+SMATX(5,IS1)-SON4)/(XPON+(XPON-1.)*DMATX(7,N))
      DN5=DN4
      SON5=SON4*DMATX(6,N)
      SMATX(2,OS1)=SMATX(2,IS1)*(1.-DMATX(5,N))/(DMATX(6,N)-DMATX(5,N))
      SMATX(2,OS2)=SMATX(2,IS1)*(1.-DMATX(6,N))/(DMATX(5,N)-DMATX(6,N))
      SMATX(4,OS1)=SMATX(4,IS1)*DMATX(6,N)
      SMATX(4,OS2)=SMATX(4,IS1)*DMATX(5,N)
      SMATX(5,OS1)=SON5
      SMATX(5,OS2)=SON4*DMATX(5,N)
      SMATX(6,OS1)=SMATX(6,IS1)*DMATX(6,N)*SBOD4/SMATX(8,IS1)
      SMATX(6,OS2)=SMATX(6,IS1)*DMATX(5,N)*SBOD4/SMATX(8,IS1)
      SMATX(7,OS1)=SMATX(7,IS1)*DMATX(6,N)
      SMATX(7,OS2)=SMATX(7,IS1)*DMATX(5,N)
      SMATX(8,OS1)=SBOD4*DMATX(6,N)
      SMATX(8,OS2)=SBOD4*DMATX(5,N)
      SMATX(9,OS1)=SBOD4*DMATX(6,N)+SON5+SMATX(4,IS1)*DMATX(6,N)
      SMATX(9,OS2)=SBOD4*DMATX(5,N)+SON4*DMATX(5,N)+SMATX(4,IS1)*
     . DMATX(5,N)
      SMATX(10,OS1)=SMATX(9,OS1)+SMATX(7,OS1)+SMATX(6,OS1)
      SMATX(10,OS2)=SMATX(9,OS2)+SMATX(7,OS2)+SMATX(6,OS2)
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(12,OS2)=SMATX(12,IS1)
      SMATX(13,OS1)=DN5
      SMATX(13,OS2)=DN5
      SMATX(14,OS1)=SMATX(14,IS1)+SMATX(6,IS1)*(1.-SBOD4/SMATX(8,IS1))
      SMATX(14,OS2)=SMATX(14,OS1)
      SMATX(15,OS1)=SMATX(15,IS1)
      SMATX(15,OS2)=SMATX(15,IS1)
      SMATX(16,OS1)=SMATX(16,IS1)
      SMATX(16,OS2)=SMATX(16,IS1)
      SMATX(17,OS1)=DBODO
      SMATX(17,OS2)=SMATX(17,OS1)
      SMATX(3,OS1)=(SBOD5+1.87*SMATX(4,OS1))/1.87
      SMATX(3,OS2)=(SMATX(8,OS2)+1.87*SMATX(4,OS2))/1.87
      SMATX(11,OS1)=(DBODO+1.87*SMATX(12,OS1))/1.87
      SMATX(11,OS2)=SMATX(11,OS1)
```

```
   PCR=(BODIN-DMATX(1,N))*100./BODIN
   AFS=SMATX(2,IS1)*1000./DMATX(8,N)*DMATX(15,N)
   VOL=FAREA*DEPTH*DMATX(16,N)
   Q6=Q6*DMATX(14,N)
   IF(DMATX(4,N)-25.) 10,20,20
10 CCOST(N,1)=4.81*VOL**.907/1000.
   GO TO 30
20 CCOST(N,1)=25.*VOL**.827/1000.
30 CCOST(N,2)=(12600.*AFS+5350./AFS**.126)/1000.
   CCOST(N,3)=0.
   COSTO(N,1)=SMATX(2,IS1)*(800.+7200.*(1./SMATX(2,IS1))**.69)/1000.
   COSTO(N,2)=0.
   COSTO(N,3)=0.
   IF(Q6) 50,50,40
40 CCOST(N,3)=(3650.+1125.*Q6)/1000.
   COSTO(N,3)=.05*CCOST(N,3)+(1911.*Q6*(DEPTH+6.)*DMATX(1,20))/1000.
50 OMATX(1,N)=AFS
   OMATX(2,N)=VOL
   OMATX(3,N)=FAREA
   OMATX(4,N)=DEPTH
   RETURN
   END
```

STREAM MIXER

```
      SUBROUTINE MIX
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      SMATX(2,OS1)=SMATX(2,IS1)+SMATX(2,IS2)
      IF(SMATX(2,OS1)) 10,30,10
   10 TEMP1=SMATX(2,IS1)/(SMATX(2,IS1)+SMATX(2,IS2))
      TEMP2=SMATX(2,IS2)/(SMATX(2,IS1)+SMATX(2,IS2))
      DO 20 I=3,17
   20 SMATX(I,OS1)=TEMP1*SMATX(I,IS1)+TEMP2*SMATX(I,IS2)
   30 RETURN
      END
```

STREAM SPLITTER

```
      SUBROUTINE SPLIT
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      DO 10 I=3,17
      SMATX(I,OS1)=SMATX(I,IS1)
   10 SMATX(I,OS2)=SMATX(I,IS1)
      RETURN
      END
```

DIGESTER

```
      SUBROUTINE DIG
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      C1DIG=.28/EXP(.036*(35.-DMATX(2,N)))
      C2DIG=700.*EXP(.10*(35.-DMATX(2,N)))
      IF(DMATX(1,N)-10.) 10,10,20
   10 DMATX(1,N)=10.
   20 DIG13=C2DIG/(C1DIG*DMATX(1,N)-1.)
      DIG12=SMATX(3,IS1)-SMATX(4,IS1)+SMATX(11,IS1)-SMATX(12,IS1)
      TEMP1=(DIG12-DIG13)/(SMATX(3,IS1)+SMATX(11,IS1))
      SMATX(2,OS1)=SMATX(2,IS1)
      SMATX(3,OS1)=SMATX(4,IS1)+.75*DIG13
      SMATX(4,OS1)=SMATX(4,IS1)
      SMATX(5,OS1)=(1.-TEMP1)*SMATX(5,IS1)
      SMATX(6,OS1)=(1.-TEMP1)*SMATX(6,IS1)
      SMATX(7,OS1)=SMATX(7,IS1)
      SMATX(8,OS1)=(SMATX(3,OS1)-SMATX(4,OS1))*1.87
      SMATX(9,OS1)=SMATX(3,OS1)*2.38
      SMATX(10,OS1)=SMATX(9,OS1)+SMATX(7,OS1)
      SMATX(11,OS1)=SMATX(12,IS1)+.25*DIG13
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(13,OS1)=SMATX(13,IS1)+SMATX(5,IS1)*.65*TEMP1
      SMATX(14,OS1)=SMATX(14,IS1)+TEMP1*SMATX(6,IS1)
      SMATX(15,OS1)=SMATX(15,IS1)
      SMATX(16,OS1)=SMATX(16,IS1)+(SMATX(13,OS1)-SMATX(13,IS1))*3.57
      SMATX(17,OS1)=(SMATX(11,OS1)-SMATX(12,OS1))*1.87
      VDIG=SMATX(2,IS1)*DMATX(1,N)*1000./7.48*DMATX(16,N)
      CH4=163.85*(DIG12-DIG13)*SMATX(2,IS1)
      CO2=249.9*(DIG12-DIG13)*SMATX(2,IS1)-CH4
      CCOST(N,1)=1.04*VDIG+10.7*VDIG**.128
      CCOST(N,2)=5.+.04*VDIG
      COSTO(N,1)=.048*VDIG+.54*VDIG**.44
      OMATX(1,N)=C1DIG
      OMATX(2,N)=C2DIG
      OMATX(3,N)=VDIG
      OMATX(4,N)=CH4
      OMATX(5,N)=CO2
      RETURN
      END
```

VACUUM FILTER

```
      SUBROUTINE VACF
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      SMATX(10,OS2)=DMATX(3,N)
      Y1=100.*SMATX(16,IS1)/SMATX(10,IS1)
      Y2=SMATX(9,IS1)/(SMATX(10,IS1)-SMATX(9,IS1))
      FECL3=1.08*Y1+2.*Y2
      WP=88./(SMATX(10,IS1)/10000.)**.123
      TEMP1=1000000.*(100.-WP)/WP
      SMATX(2,OS2)=SMATX(2,IS1)*(TEMP1-SMATX(10,IS1))/(TEMP1-
     . SMATX(10,OS2))
      SMATX(10,OS1)=8.33*(SMATX(2,IS1)*SMATX(10,IS1)-SMATX(2,OS2)*
     . SMATX(10,OS2))
      TEMP2=SMATX(10,OS1)/SMATX(10,IS1)
      TEMP3=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP2*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP3*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS1)=TEMP2*SMATX(I,IS1)
   20 SMATX(I,OS2)=SMATX(I,IS1)
      AVF=SMATX(2,OS2)*1000000./DMATX(1,N)/DMATX(2,N)/24.*DMATX(16,N)
      CCOST(N,1)=12.8+.372*AVF
      CCHEM=SMATX(10,IS1)*FECL3*SMATX(2,IS1)*30.4*DMATX(7,20)
      COSTO(N,1)=CCHEM/1000.+1.5*SMATX(2,IS1)+6.45*SMATX(2,IS1)**.37
      OMATX(1,N)=DMATX(7,20)
      OMATX(2,N)=FECL3
      OMATX(3,N)=WP
      OMATX(4,N)=AVF
      OMATX(5,N)=CCHEM
      RETURN
      END
```

SLUDGE ELUTRIFICATION

```
      SUBROUTINE ELUT
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,IS2)=DMATX(3,N)*SMATX(2,IS1)
      TEMP1=SMATX(2,IS1)*1000000./DMATX(4,N)
      TEMP2=SMATX(2,IS1)*SMATX(10,IS1)*8.33/DMATX(5,N)
      IF(TEMP1-TEMP2) 20,20,10
   10 AE=TEMP1*DMATX(16,N)
      GO TO 30
   20 AE=TEMP2*DMATX(16,N)
   30 SMATX(2,OS1)=DMATX(1,N)*SMATX(2,IS1)*SMATX(10,IS1)/SMATX(10,OS1)
      SMATX(2,OS2)=SMATX(2,IS1)+SMATX(2,IS2)-SMATX(2,OS1)
      SMATX(10,OS2)=SMATX(2,IS1)*((1.-DMATX(1,N))*SMATX(10,IS1)+
     . DMATX(3,N)*SMATX(10,IS2))/SMATX(2,OS2)
      TEMP3=SMATX(10,OS1)/SMATX(10,IS1)
      TEMP4=SMATX(10,OS2)/SMATX(10,IS1)
      DO 40 I=3,9
      SMATX(I,OS1)=TEMP3*SMATX(I,IS1)
   40 SMATX(I,OS2)=TEMP4*SMATX(I,IS2)
      TEMP5=SMATX(2,IS1)/(SMATX(2,IS1)+SMATX(2,IS2))
      TEMP6=SMATX(2,IS2)/(SMATX(2,IS1)+SMATX(2,IS2))
      DO 50 I=11,17
      SMATX(I,OS2)=TEMP5*SMATX(I,IS1)+TEMP6*SMATX(I,IS2)
   50 SMATX(I,OS1)=SMATX(I,OS2)
      CCOST(N,1)=(.0181+.0495/EXP(AE/6000.))*AE
      COSTO(N,1)=0.
      OMATX(1,N)=AE
      RETURN
      END
```

SLUDGE THICKENING

```
      SUBROUTINE THICK
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACCST(20,5),TCOST(20,5)
      SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,OS1)=DMATX(1,N)*SMATX(2,IS1)*SMATX(10,IS1)/SMATX(10,OS1)
      SMATX(2,OS2)=SMATX(2,IS1)-SMATX(2,OS1)
      SMATX(10,OS2)=(1.-DMATX(1,N))*SMATX(2,IS1)*SMATX(10,IS1)/
     . SMATX(2,OS2)
      TEMP1=SMATX(10,OS1)/SMATX(10,IS1)
      TEMP2=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS1)=SMATX(I,IS1)
   20 SMATX(I,OS2)=SMATX(I,IS1)
      ATH1=SMATX(2,IS1)*1000000./DMATX(3,N)
      ATH2=SMATX(2,IS1)*SMATX(10,IS1)*8.33/DMATX(4,N)
      IF(ATH1-ATH2) 40,40,30
   30 ATHM=ATH1*DMATX(16,N)
      GO TO 50
   40 ATHM=ATH2*DMATX(16,N)
   50 CCOST(N,1)=(.0181+.00846/EXP(ATHM/13375.))*ATHM
      COSTO(N,1)=0.
      OMATX(1,N)=ATHM
      RETURN
      END
```

SLUDGE DRYING BEDS

```
SUBROUTINE SBEDS
INTEGER OS1,OS2
COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
. INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
. ACOST(20,5),TCOST(20,5)
ASB=SMATX(10,IS1)*SMATX(2,IS1)*8.33*30./DMATX(1,N)*DMATX(16,N)
CCOST(N,1)=.0023*ASB
COSTO(N,1)=0.
OMATX(1,N)=ASB
RETURN
END
```

CHLORINATION

```
      SUBROUTINE CHLOR
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      CCOST(N,1)=(9.*(DMATX(2,N)*SMATX(2,IS1)/15.)**.469)*DMATX(16,N)
      COSTO(N,1)=.001*DMATX(1,N)*SMATX(2,IS1)*8.33*365.*DMATX(8,20)*
     . DMATX(16,N)
      DO 10 I=2,20
   10 SMATX(I,OS1)=SMATX(I,IS1)
      OMATX(1,N)=DMATX(8,20)
      RETURN
      END
```

CALCULATE TOTAL PLANT COSTS

```
      SUBROUTINE COST
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      TCAP=0.
      DO 10 J=1,20
      DO 10 I=1,5
      CCOST(J,I)=CCOST(J,I)*DMATX(2,20)
   10 TCAP=TCAP+CCOST(J,I)
      CENG=.08*(1000./TCAP)**.146
      CCR=1.+CENG+DMATX(4,20)+DMATX(5,20)+DMATX(6,20)
      TCAP=TCAP*CCR
      DO 20 J=1,20
      DO 20 I=1,5
   20 CCOST(J,I)=CCOST(J,I)*CCR
      TAMM=0.
      DO 30 J=1,20
      DO 30 I=1,5
      ACOST(J,I)=DMATX(3,20)*CCOST(J,I)/3.65/SMATX(2,1)
   30 TAMM=TAMM+ACOST(J,I)
      TOPER=0.
      DO 40 J=1,20
      DO 40 I=1,5
      COSTO(J,I)=COSTO(J,I)/3.65/SMATX(2,1)
   40 TOPER=TOPER+COSTO(J,I)
      TOTAL=0.
      DO 50 J=1,20
      DO 50 I=1,5
      TCOST(J,I)=COSTO(J,I)+ACOST(J,I)
   50 TOTAL=TOTAL+TCOST(J,I)
      OMATX(1,20)=CENG
      OMATX(2,20)=CCR
      OMATX(3,20)=TCAP
      OMATX(4,20)=TAMM
      OMATX(5,20)=TOPER
      OMATX(6,20)=TOTAL
      RETURN
      END
```

PRINT OUTPUT

```
      SUBROUTINE PRINT
      INTEGER OS1,OS2
      COMMON SMATX(20,25),TMATX(20,25),DMATX(20,20),OMATX(20,20),IP(25),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5)
      WRITE(IO,10)
   10 FORMAT(1H1,//,55X,'STREAM CHARACTERISTICS',//,65X,'VOLUME FLOW, MI
     .LLIONS OF GALLONS PER DAY',  /,65X,'CONCENTRATIONS, MILLIGRAMS/LIT
     .ER',/)
      DO 30 I=1,25
      IF(SMATX(1,I)) 20,30,20
   20 WRITE(IO,40) SMATX(1,I)
      WRITE(IO,50) (SMATX(J,I),J=2,9)
      WRITE(IO,60)
      WRITE(IO,70) SMATX(16,I),(SMATX(J,I),J=11,15),SMATX(17,I),
     . SMATX(10,I)
   30 CONTINUE
   40 FORMAT(2X,1HS,F3.0,12X,1HQ,9X,3HSOC,7X,4HSNBC,8X,3HSON,8X,3HSOP,
     .  8X,3HSFM,7X,4HSBOD,8X,3HVSS)
   50 FORMAT(13X,8F11.3)
   60 FORMAT(16X,3HALK,8X,3HDOC,7X,4HDNBC,9X,2HDN,9X,2HDP,8X,3HDFM,7X,
     .  4HDBOD,8X,3HTSS)
   70 FORMAT(13X,8F11.3//)
      WRITE(IO,80)
   80 FORMAT(1H1,//,45X,'PROCESS CHARACTERISTICS',//,55X,'CCOST = CAPITA
     .L COST, THOUSANDS OF DOLLARS', /,55X,'COSTO = OPERATING + MAINTENA
     .NCE COST, CENTS/1000 GAL.',/,55X,'ACOST = AMORTIZATION COST, CENTS
     ./1000 GAL.',/,55X,'TCOST = TOTAL TREATMENT COST, CENTS/1000 GAL.',
     .//)
      DO 1500 I=1,25
      IF(IP(I)) 90,1500,90
   90 KK=IP(I)
      GO TO (100,150,200,1500,1500,250,300,350,400,450,500,550),KK
  100 WRITE(IO,110) I,CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),
     . DMATX(16,I)
  110 FORMAT(1X,1HP,I2,2X,'PRELIMINARY',42X,'CCOST',5X,'COSTO',5X,
     . 'ACOST',5X,'TCOST',5X,'ECF',/T7,'TREATMENT',44X,F7.2,3X,F7.2,3X,
     . F7.2,3X,F7.2,2X,F3.1,//)
      GO TO 1500
  150 WRITE(IO,160) I,DMATX(1,I),DMATX(2,I),OMATX(1,I),OMATX(2,I),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
  160 FORMAT(1X,1HP,I2,2X,'PRIMARY',7X,'FRPS',6X,'URPS',6X,'GPS',7X,'APS
     .',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF' ,/,6X,'SETT
     .LER',11X,F5.3,2X,F5.0,5X,F6.1,6X,F6.3,2X,F7.2,3X,F7.2,3X,F7.2,3X,
     .F7.2,2X,F3.1,//)
      GO TO 1500
  200 WRITE(IO,210) I,OMATX(1,I),DMATX(1,I),DMATX(3,I),DMATX(4,I),
     . DMATX(5,I),CMATX(2,I),DMATX(6,I),DMATX(7,I),OMATX(3,I),CMATX(4,I)
  210 FORMAT(1X,1HP,I2,2X,'AERATOR',6X,'BOD2',6X,'BOD5',8X,'DEGC',6X,
     . 'CAER20',4X,'DO',8X,'DOSAT',5X,'AEFF20',4X,'URSS',6X,'XRSS',6X,
     . 'AFS',/,4X,'FINAL SETTLER',F9.1,5X,F4.1,6X,F3.0,7X,F5.3,4X,F3.0,
     . 7X,F4.1,6X,F5.3,5X,F5.2,5X,F6.4,4X,F5.2)
      WRITE(IO,220) DMATX(8,I),OMATX(5,I),OMATX(6,I),OMATX(7,I),
     . OMATX(8,I),DMATX(2,I),OMATX(9,I),OMATX(10,I),OMATX(11,I)
  220 FORMAT(T20,'GSS',7X,'CAER',6X,'CEDR',6X,'VAER',6X,'VNIT',6X,
     . 'MLSS',6X,'MLASS',5X,'MLBSS',5X,'MLNBSS',/T21,F5.0,5X,F5.3,5X,
     . F5.3,5X,F5.3,4X,F5.3,4X,F6.0,4X,F6.0,4X,F6.0,4X,F6.0)
```

PRINT OUTPUT

```
    WRITE(IO,230) OMATX(12,I),OMATX(13,I),OMATX(14,I),OMATX(15,I),
   . OMATX(16,I),OMATX(17,I),OMATX(18,I),OMATX(19,I),OMATX(20,I)
230 FORMAT(T20,'MLDSS',5X,'MLISS',5X,'FOOD',6X,'RTURN',5X,'CNIT',6X,
   . 'CKWH',6X,'AIRCFD',5X,'BSIZE',4X,'CFPGAL',/T21,F6.0,4X,F6.0,4X,
   . F5.1,6X,F5.3,4X,F5.3,5X,F5.3,4X,F10.0,2X,F6.0,3X,F4.2,//)
    WRITE(IO,235) DMATX(16,I),CCOST(I,1),COSTO(I,1),ACOST(I,1),
   . TCOST(I,1),DMATX(15,I),CCOST(I,2),COSTO(I,2),ACOST(I,2),
   . TCOST(I,2)
235 FORMAT(T33,'ECF',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',/T20,
   . 'AERATOR',7X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,//T20,'BLOWER',
   . 8X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/)
    WRITE(IO,240) DMATX(14,I),CCOST(I,3),COSTO(I,3),ACOST(I,3),
   . TCOST(I,3),DMATX(13,I),CCOST(I,4),COSTO(I,4),ACOST(I,4),
   . TCOST(I,4)
240 FORMAT(20X,'SLUDGE',7X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/,20X,
   . 'PUMPS',//,20X,'FINAL',8X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,
   . /,20X,'SETTLER',///)
    GO TO 1500
250 WRITE(IO,260) I,DMATX(1,I),DMATX(2,I),OMATX(1,I),OMATX(2,I),
   . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
260 FORMAT(1X,1HP,I2,2X,'DIGESTER',6X,'TD',8X,'TDIG',6X,'C1DIG',5X,
   . 'C2DIG',5X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/,
   . 23X,F4.1,8X,F4.1,5X,F5.3,2X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,3X,
   . F7.2,2X,F3.1)
    WRITE(IO,270) OMATX(3,I),OMATX(4,I),OMATX(5,I)
270 FORMAT(20X,'WDIG',6X,'CH4CFD',4X,'CO2CFD',/21X,F6.1,4X,F7.0,3X,
   . F7.0//)
    GO TO 1500
300 WRITE(IO,310) I,DMATX(1,I),DMATX(2,I),OMATX(1,I),OMATX(2,I),
   . CCOST(I,1),CCSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
   . OMATX(3,I),OMATX(4,I),OMATX(5,I)
310 FORMAT(1X,1HP,I2,2X,'VACUUM',7X,'VFL',7X,'TVF',7X,'CFECL3',4X,
   . 'FECL3',5X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/T7,
   . 'FILTER',8X,F4.1,6X,F5.3,5X,F5.3,5X,F6.2,4X,F7.2,3X,F7.2,3X,F7.2,
   . 3X,F7.2,2X,F3.1,/T20,'WP',8X,'AVF',7X,'CCHEM',/T21,F4.1,6X,F6.1,
   . 4X,F7.0,//)
    GO TO 1500
350 WRITE(IO,360) I,DMATX(1,I),DMATX(3,I),DMATX(4,I),OMATX(1,I),
   . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
360 FORMAT(1X,1HP,I2,2X,'THICKENER',4X,'TRR',7X,'GTH',7X,'GSTH',6X,
   . 'ATHM',6X,'CCCST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/T21,
   . F5.3,5X,F5.0,5X,F4.1,6X,F7.0,3X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,2X,
   . F3.1,//)
    GO TO 1500
400 WRITE(IO,410) I,DMATX(1,I),DMATX(3,I),DMATX(4,I),DMATX(5,I),
   . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
   . OMATX(1,I)
410 FORMAT(1X,1HP,I2,2X,'ELUTRIATE',5X,'ERR',7X,'WRE',7X,'GE',8X,
   . 'GES',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/24X,
   . F5.3,5X,F3.1,5X,F4.0,7X,F4.1,4X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,
   . 2X,F3.1,/,20X,'AE',/,21X,F6.1,//)
    GO TO 1500
450 WRITE(IO,460) I,DMATX(1,I),OMATX(1,I),CCOST(I,1),COSTO(I,1),
   . ACOST(I,1),TCOST(I,1),DMATX(16,I)
460 FORMAT(1X,1HP,I2,2X,'SLUDGE',7X,'SBL',7X,'ASB',27X,'CCOST',5X,
   . 'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/6X,'BEDS',10X,F3.1,7X,
   . F7.0,23X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,2X,F3.1,//)
```

```
                                                      PRINT OUTPUT

      GO TO 1500
  500 WRITE(IO,510) I,DMATX(1,I),DMATX(2,I),DMATX(5,I),DMATX(6,I),
     . DMATX(4,I),DMATX(3,I),DMATX(7,I),DMATX(1,I),DMATX(8,I),
     . DMATX(2,I),DMATX(3,I),DMATX(4,I)
  510 FORMAT(1X,1HP,I2,2X,'TRICKLING',7X,'BODOUT',4X,'DEGC',5X,'URSS',
     . 5X,'XRSS',5X,'SAREA',4X,'HQ',4X,'RECYCL',5X,'AFS',5X,'GSS',/,7X,
     . 'FILTER',9X,F5.1,5X,F4.0,4X,F5.2,4X,F6.4,4X,F4.1,4X,F4.1,4X,F4.1,
     . 4X,F5.2,3X,F5.0,/,4X,'FINAL SETTLER', 9X,'VOL',13X,'FAREA',7X,
     . 'DEPTH',/,22X,F12.3,4X,F12.3,4X,F7.2,//)
      WRITE(IO,520) DMATX(16,I),CCOST(I,1),COSTO(I,1),ACOST(I,1),
     . TCOST(I,1),DMATX(15,I),CCOST(I,2),COSTO(I,2),ACOST(I,2),
     . TCOST(I,2),DMATX(14,I),CCOST(I,3),COSTO(I,3),ACOST(I,3),
     . TCOST(I,3)
  520 FORMAT(T33,'ECF',7X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',
     . /T20,'FILTER',8X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,//T20,
     . 'FINAL', 9X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/T20,'SETTLER',
     . //T20,'SLUDGE',8X,F3.1,5X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,/
     . T20,'PUMPS',///)
      GO TO 1500
  550 WRITE(IO,560) I,DMATX(8,20),DMATX(1,I),DMATX(2,I),CCOST(I,1),
     . COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
  560 FORMAT(1X,1HP,I2,2X,'CHLORINATE',4X,'CCL2',6X,'DCL2',7X,'TCL2',
     . 15X,'CCOST',5X,'COSTO',5X,'ACOST',5X,'TCOST',5X,'ECF',/,24X,F5.2,
     . 3X,F5.2,3X,F5.2,16X,F7.2,3X,F7.2,3X,F7.2,3X,F7.2,2X,F3.1,//)
 1500 CONTINUE
      WRITE(IO,1600) DMATX(2,20),DMATX(3,20),DMATX(1,20),DMATX(4,20),
     . DMATX(5,20),DMATX(6,20),DMATX(2,20)
 1600 FORMAT(1H1,//////,49X'TOTAL  PLANT  COST',///,19X,'CCI',7X,'AF',
     . 8X,'ENG',7X,'CTRP',6X,'CTGO',6X,'CLAND',5X,'CCR',/,19X,F5.3,5X,
     . F6.4,4X,F5.3,5X,F5.3,5X,F5.3,5X,F5.3,5X,F4.2,//)
      WRITE(IO,1610) DMATX(3,20),DMATX(4,20),DMATX(5,20),DMATX(6,20)
 1610 FORMAT(19X,'TOTAL CAPITAL COST = ',F10.2,' THOUSANDS OF DOLLARS',
     . //,14X,'TOTAL AMORTIZATION COST = ',F7.2,' CENTS/ 1000 GALS.',//,
     . 21X,'TOTAL O + M COST = ',F7.2,' CENTS/ 1000 GALS.',//,17X,
     . 'TOTAL TREATMENT COST = ',F7.2,' CENTS/ 1000 GALS.')
      RETURN
      END
```

FIGURE IV

INPUT DATA

K	N	PROCESS		IS1	IS2	OS1	OS2	III
0	7	1	PREL	1	0	3	0	2
1	0	4	MIX	3	9	20	0	1
0	1	2	PRSET	20	0	2	8	0
0	2	3	AERFS	2	0	5	7	0
0	0	5	SPLIT	5	0	24	17	0
0	0	4	MIX	7	8	10	0	0
0	3	8	THICK	10	0	12	11	0
0	4	6	DIG	12	0	13	0	0
0	5	9	ELUT	13	17	15	14	0
0	6	7	VACF	15	0	18	16	0
0	0	4	MIX	11	14	21	0	0
1	0	4	MIX	16	21	9	0	1
0	8	12	CHLOR	24	0	25	0	2
0	9	10	SBEDS	18	0	19	0	2
9	0	0		0	0	0	0	0

```
                                        STREAM CHARACTERISTICS

                                                      VOLUME FLOW, MILLIONS OF GALLONS PER DAY
                                                      CONCENTRATIONS, MILLIGRAMS/LITER

S 1.          Q         SOC        SNBC       SON        SOP        SFM        SBOD       VSS
            10.000    105.000     30.000     10.000      2.000     30.000    140.200    223.600
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           250.000     43.000     11.000     19.100      4.000    500.000     59.840    253.600

S 2.          Q         SCC        SNBC       SON        SCP        SFM        SBOD       VSS
            10.276     53.324     15.403      5.142      1.007     15.313     70.956    113.787
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           265.470     42.438     11.000     23.376      4.845    500.000     58.789    141.300

S 3.          Q         SCC        SNBC       SON        SCP        SFM        SBOD       VSS
            10.000    105.000     30.000     10.000      2.000     30.000    140.200    223.600
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           250.000     43.000     11.000     19.100      4.000    500.000     59.840    253.600

S 5.          Q         SCC        SNBC       SON        SOP        SFM        SBOD       VSS
            10.113      9.044      4.046      1.494      0.090      3.173     10.045     21.526
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           265.470     12.582     11.000     21.309      5.417    500.000      2.958     24.700

S 7.          Q         SOC        SNBC       SON        SOP        SFM        SBOD       VSS
             0.163   2184.711    977.525    360.880     21.847    766.651   2426.548   5199.612
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           265.470     12.582     11.000     21.309      5.417    500.000      2.958   5966.262

S 8.          Q         SOC        SNBC       SON        SOP        SFM        SBOD       VSS
             0.012  42605.953  12307.224   4108.516    804.978  12235.300  56694.023  90916.203
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           265.470     42.438     11.000     23.376      4.845    500.000     58.789 112898.812

S 9.          Q         SOC        SNBC       SON        SOP        SFM        SBOD       VSS
             0.289    158.803     57.279     19.635      2.442     50.892    194.721    354.676
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           799.445     23.043     10.999    170.974     34.046    500.000     22.521   1271.049

S10.          Q         SOC        SNBC       SON        SOP        SFM        SBOD       VSS
             0.176   5134.269   1804.258    634.347     78.992   1603.524   6386.472  11454.392
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           265.470     14.760     11.000     21.460      5.375    500.000      7.032  13769.181

S11.          Q         SOC        SNBC       SON        SOP        SFM        SBOD       VSS
             0.137    328.283    115.363     40.559      5.050    102.528    408.349    732.390
          ALK       DOC        DNBC       DN         DP         DFM        DBOD       TSS
           265.470     14.760     11.000     21.460      5.375    500.000      7.032    880.397
```

```
S12.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.038  22372.871     7862.160     2764.205     344.214     6987.448    27829.418    49913.164
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
          265.470       14.760       11.000       21.460       5.375      500.000        7.032    60000.007

S13.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.038   8082.650     7862.160     1008.399     125.571     6987.448      412.316    19236.703
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
         4339.815       84.496       11.000     1162.734     224.018      500.000      137.438    26224.148

S14.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.140        0.598        0.267        0.098       0.005        0.210        0.665        1.425
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
         1284.056       30.560       11.000      306.665      60.067      500.000       36.578     1736.149

S15.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.012  18492.843    17988.367     2307.185     287.303    15987.054      943.367    44012.953
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
         1284.056       30.560       11.000      306.665      60.067      500.000       36.578    60000.007

S16.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.010       61.642       59.961        7.690       0.957       53.290        3.144      146.709
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
         1284.056       30.560       11.000      306.665      60.067      500.000       36.578      200.000

S17.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.115        9.044        4.046        1.494       0.090        3.173       10.045       21.526
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
          265.470       12.582       11.000       21.309       5.417      500.000        2.958       24.700

S18.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.000     1960.726     1907.238      244.622      30.461     1695.047      100.021     4666.527
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
          136.143        3.240        1.166       32.514       6.368       53.013        3.878     6361.575

S19.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.000        0.000        0.000        0.000       0.000        0.000        0.000        0.000
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
            0.000        0.000        0.000        0.000       0.000        0.000        0.000        0.000

S20.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
           10.289      106.514       30.768       10.271       2.012       30.588      141.735      227.290
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
          265.470       42.438       11.000       23.376       4.845      500.000       58.789      282.247

S21.        Q          SOC         SNBC         SON          SOP          SFM          SBOD         VSS
            0.278      162.613       57.173       20.103       2.500       50.798      202.233      362.830
          ALK          DOC        DNBC          DN           DP           DFM          DBOD         TSS
```

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              780.443     22.748     10.999    165.653     33.026    500.000     21.970   1313.046

S24.             Q         SOC        SNBC        SON        SCP        SFM        SBOD        VSS
                 9.998      9.044      4.046      1.494      0.090      3.173     10.045     21.526
              ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
               265.470     12.582     11.000     21.309      5.417    500.000      2.958     24.700

S25.             Q         SOC        SNBC        SON        SCP        SFM        SBOD        VSS
                 9.998      9.044      4.046      1.494      0.090      3.173     10.045     21.526
              ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
               265.470     12.582     11.000     21.309      5.417    500.000      2.958     24.700
```

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                                   PROCESS CHARACTERISTICS

                                                  CCOST = CAPITAL COST, THOUSANDS OF DOLLARS
                                                  COSTO = OPERATING + MAINTENANCE COST, CENTS/1000 GAL.
                                                  ACOST = AMORTIZATION COST, CENTS/1000 GAL.
                                                  TCOST = TOTAL TREATMENT COST, CENTS/1000 GAL.


P 1  PRIMARY        FRPS      URPS      GPS       APS       CCOST     COSTO     ACOST     TCOST     ECF
     SETTLER           0.500   400.      1375.2     14.964   314.82      0.67      0.57      1.25   2.0

P 2  AERATOR        BOD2      BOD5       DEGC      CAER20    DO         DOSAT     AEFF20    URSS      XRSS      AFS
   FINAL SETTLER     129.7      13.0      20.       1.000    1.         10.7      0.050     3.00      0.0124    15.10
                    GSS       CAER      CEDR      VAER      VNIT      MLSS      MLASS     MLBSS     MLNBSS
                     2000.     1.000     0.124     2.307    2.515     2000.     871.      264.      547.
                    MLDSS     MLISS     FOOD      RTURN     CNIT      CKWH      AIRCFD    BSIZE     CFPGAL
                        62.       255.    111.6      0.470    0.321     0.010    9539840.  9937.    0.92

                              ECF       CCOST     COSTO     ACOST     TCOST
                    AERATOR     1.2      677.63      1.23      1.24      2.47

                    BLOWER      1.5      104.42      0.52      0.19      0.71

                     SLUDGE     2.0       22.04      0.00      0.04      0.04
                     PUMPS

                     FINAL      2.0      294.81      0.00      0.54      0.54
                     SETTLER


P 3  THICKENER      TRR       GTH       GSTH      ATHM      CCOST     COSTO     ACOST     TCOST     ECF
                     0.950     750.       9.0       3369.    126.25      0.00      0.23      0.23   1.5

P 4  DIGESTER        TD        TDIG      C1DIG     C2DIG     CCOST     COSTO     ACOST     TCOST     ECF
                        15.0      33.0     0.260   854.98    274.35      0.33      0.50      0.84   2.0
                     VDIG      CH4CFD    CO2CFD
                      154.1     89537.    47023.

P 5  ELUTRIATE       ERR       WRE       GE        GES       CCOST     COSTO     ACOST     TCOST     ECF
                        0.760      3.0    800.         9.0   121.73      0.00      0.22      0.22   1.5
                     AE
                      1399.0

P 6  VACUUM         VFL       TVF       CFECL3    FECL3     CCOST     COSTO     ACOST     TCOST     ECF
     FILTER           4.9      0.238     0.080      7.81     240.04      0.43      0.44      0.87   1.0
                    WP        AVF       CCHEM
                     70.5       390.5     14560.

P 7  PRELIMINARY                                            CCOST     COSTO     ACOST     TCOST     ECF
     TREATMENT                                               94.12      0.27      0.17      0.44   1.0
```

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P 8  CHLORINATE    CCL2       DCL2       TCL2                CCOST     COSTO     ACOST     TCOST     ECF
                          0.08      8.00    30.00                 55.69      0.53      0.10      0.63  1.0

P 9  SLUDGE        SBL        ASB                            CCOST     COSTO     ACOST     TCOST     ECF
     BEDS           4.4              0.                            0.00      0.00      0.00      0.00  1.0
```

```
                         TOTAL  PLANT  COST

   CCI      AF       ENG      CTRP     CTGO     CLAND    CCR
   1.130    0.0670   0.073    0.100    0.150    0.020    1.34

   TOTAL CAPITAL COST =    2342.91 THOUSANDS OF DOLLARS

TOTAL AMORTIZATION COST =    4.30 CENTS/ 1000 GALS.

      TOTAL O + M COST =    4.01 CENTS/ 1000 GALS.

  TOTAL TREATMENT COST =    8.31 CENTS/ 1000 GALS.
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ADVANCED WASTE TREATMENT RESEARCH LABORATORY

EXECUTIVE DIGITAL COMPUTER PROGRAM FOR PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

SHEET 1

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE OF
PROGRAMMER	DATE		PUNCH	CARD ELECTRO NUMBER

NIS	NN(1)	NN(2)	NN(3)	NN(4)	NN(5)	NN(6)	NN(7)	NN(8)	NN(9)	NN(10)	EPS

INPUT STREAM VECTORS

Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
TSS	DOC	DNBC	DN	DP	DFM	ALK	DBOD

Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
TSS	DOC	DNBC	DN	DP	DFM	ALK	DBOD

Q	SOC	SNBC	SON	SOP	SFM	SBOD	VSS
TSS	DOC	DNBC	DN	DP	DFM	ALK	DBOD

COST CONSTANTS

CKWH	CCI	AF	CTRP	CTGO	CLAND	CFECL3	CCL2

FIGURE V

ADVANCED WASTE TREATMENT RESEARCH LABORATORY
EXECUTIVE DIGITAL COMPUTER PROGRAM FOR PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

SHEET 2

DATE	PUNCHING INSTRUCTIONS	GRAPHIC PUNCH	PAGE OF CARD ELECTRO NUMBER*

K	N	IPROC	NAME	I$1	I$2	OS1	OS2		III
DMATX(1,N)		DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)	
DMATX(9,N)		DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	DMATX(16,N)	

K	N	IPROC	NAME	I$1	I$2	OS1	OS2		III
DMATX(1,N)		DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)	
DMATX(9,N)		DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	DMATX(16,N)	

K	N	IPROC	NAME	I$1	I$2	OS1	OS2		III
DMATX(1,N)		DMATX(2,N)	DMATX(3,N)	DMATX(4,N)	DMATX(5,N)	DMATX(6,N)	DMATX(7,N)	DMATX(8,N)	
DMATX(9,N)		DMATX(10,N)	DMATX(11,N)	DMATX(12,N)	DMATX(13,N)	DMATX(14,N)	DMATX(15,N)	DMATX(16,N)	

UPDATES

to

EXECUTIVE
DIGITAL COMPUTER PROGRAM
FOR
PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

March 1973

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FORTRAN Listing of the Executive Program 58

UNIT PROCESSES IN EXECUTIVE PROGRAM

Subroutine Name	Identification Number
PREL, preliminary treatment	1
PRSET, primary sedimentation	2
AERFS, aerator - final settler	3
MIX, stream mixer	4
SPLIT, stream splitter	5
DIG, anaerobic digestion	6
VACF, vacuum filtration	7
THICK, gravity thickening	8
ELUT, elutriation	9
SBEDS, sludge drying beds	10
TRFS, trickling filter - final settler	11
CHLOR, chlorination	12
TFLOT, flotation thickening	13
MHINC, multiple hearth incineration	14
RWP, raw wastewater pumping	15
SHT, sludge holding tanks	16
CENT, centrifugation	17
AEROB, aerobic digestion	18
POSTA, post aeration	19
EQUAL, equalization	20
DIG2, second stage anaerobic digestion	21
LANDD, land disposal of liquid sludge	22
LIME, lime addition to sludge	23

CONTENTS OF THE STREAM MATRIX (SMATX)
(I designates the stream number)

Row No.	FORTRAN Variable Name		Parameter Definition	Nominal Value for Plant Influent
1	SMATX (1,I)	I	Stream Number	-
2	SMATX (2,I)	Q	Volume Flow, mgd	10.
3	SMATX (3,I)	SOC	Solids Organic Carbon, mg/l	105.
4	SMATX (4,I)	SNBC	Solid Nonbiodegradable Carbon, mg/l	30.
5	SMATX (5,I)	SON	Solid Organic Nitrogen, mg/l	10.
6	SMATX (6,I)	SOP	Solid Organic Phosphorus, mg/l	2.
7	SMATX (7,I)	SFM	Solid Fixed Matter, mg/l	30.
8	SMATX (8,I)	SBOD	Solid BOD, mg/l	140.
9	SMATX (9,I)	VSS	Volatile Suspended Solids, mg/l	224.
10	SMATX (10,I)	TSS	Total Suspended Solids, mg/l	254.
11	SMATX (11,I)	DOC	Dissolved Organic Carbon, mg/l	43.
12	SMATX (12,I)	DNBC	Dissolved Nonbiodegradable Carbon, mg/l	11.
13	SMATX (13,I)	DN	Dissolved Nitrogen, mg/l	19.
14	SMATX (14,I)	DP	Dissolved Phosphorus, mg/l	4.
15	SMATX (15,I)	DFM	Dissolved Fixed Matter, mg/l	500.
16	SMATX (16,I)	ALK	Alkalinity, mg/l	250.
17	SMATX (17,I)	DBOD	Dissolved BOD, mg/l	60.
18	NOT USED			
19	NOT USED			
20	NOT USED			

DMATX INPUTS WITH NOMINAL VALUES

Cost (COST)	DMATX (1,20)	= CCI	1.506
	DMATX (2,20)	= WPI	1.122
	DMATX (3,20)	= RI	.06
	DMATX (4,20)	= YRS	25.
	DMATX (5,20)	= DHR	3.50
	DMATX (6,20)	= PCT	.15
	DMATX (7,20)	= DA	1000.
	DMATX (8,20)	= CCINT	.06
	DMATX (9,20)	= XLAB	1.
	DMATX (10,20)	= CKWH	.015
Preliminary Treatment (PREL)	DMATX (1,N)	= IPREL	1.
	DMATX (16,N)	= ECF	1.
Primary Sedimentation (PRSET)	DMATX (1,N)	= FRPS	.5
	DMATX (2,N)	= URPS	400.
	DMATX (3,N)	= HPWK	14.
	DMATX (15,N)	= ECF of primary sludge pumps	1.
	DMATX (16,N)	= ECF of primary settler	1.2
Aerator - Final Settler (AERFS)	DMATX (1,N)	= BOD of OS1	13.
	DMATX (2,N)	= MLSS	2000.
	DMATX (3,N)	= DEGC	20.
	DMATX (4,N)	= CAER20	1.
	DMATX (5,N)	= DO	1.

DMATX INPUTS WITH NOMINAL VALUES (Cont'd)

Aerator - Final Settler (AERFS) (Cont'd)	DMATX (6,N)	= AEFF20	.05
	DMATX (7,N)	= URSS	3.
	DMATX (8,N)	= GSS	700.
	DMATX (9,N)	= HEAD	30.
	DMATX (10,N)	= ALMD	2.3
	DMATX (13,N)	= ECF of final settler	1.2
	DMATX (14,N)	= ECF of sludge return pumps	1.
	DMATX (15,N)	= ECF of blowers	1.
	DMATX (16,N)	= ECF of aeration tanks	1.2
Stream Mixer (MIX)	NONE		
Stream Splitter (SPLIT)	NONE		
Anaerobic Digestion (DIG)	DMATX (1,N)	= TD	15.
	DMATX (2,N)	= TDIG	30.
	DMATX (16,N)	= ECF	1.3
Vacuum Filtration (VACF)	DMATX (1,N)	= VFL	4.9
	DMATX (2,N)	= HPWK	35.
	DMATX (3,N)	= TSS of OS2	200.
	DMATX (4,N)	= IVACF	1.
	DMATX (5,N)	= FE	42.
	DMATX (6,N)	= CAO	176.
	DMATX (7,N)	= CFE	.064
	DMATX (8,N)	= CCAO	.0125
	DMATX (16,N)	= ECF	1.

DMATX INPUTS WITH NOMINAL VALUES (Cont'd)

Gravity Thickening (THICK)	DMATX (1,N)	= TRR	.95
	DMATX (2,N)	= TSS of OS1	50000.
	DMATX (3,N)	= GTH	700.
	DMATX (4,N)	= GSTH	8.
	DMATX (16,N)	= ECF	1.5
Elutriation (ELUT)	DMATX (1,N)	= ERR	.76
	DMATX (2,N)	= TSS of OS1	60000.
	DMATX (3,N)	= WRE	3.
	DMATX (4,N)	= GE	800.
	DMATX (5,N)	= GES	9.
	DMATX (16,N)	= ECF	1.5
Sludge Drying Beds (SBEDS)	DMATX (1,N)	= SBL	.0078
	DMATX (2,N)	= SOUT	.35
	DMATX (3,N)	= TSS of OS2	50.
	DMATX (16,N)	= ECF	1.5
Trickling Filter - Final Settler (TRFS)	DMATX (1,N)	= BOD of OS1	26.
	DMATX (2,N)	= DEGC	20.
	DMATX (3,N)	= HQ	10.
	DMATX (4,N)	= SAREA	10.
	DMATX (5,N)	= URSS	2.
	DMATX (6,N)	= XRSS	.6
	DMATX (7,N)	= RECYCL	1.
	DMATX (8,N)	= GSS	2000.

DMATX INPUTS WITH NOMINAL VALUES (Cont'd)

Trickling Filter - Final Settler (TRFS) (Cont'd)	DMATX (9,N)	= HEAD	30.
	DMATX (14,N)	= ECF of sludge return pumps	1.5
	DMATX (15,N)	= ECF of final settler	1.2
	DMATX (16,N)	= ECF of filters	1.2
Chlorination (CHLOR)	DMATX (1,N)	= DCL2	8.
	DMATX (2,N)	= TCL2	30.
	DMATX (15, N)	= ECF of feed system	1.5
	DMATX (16,N)	= ECF of contact basin	1.2
Flotation Thickening (TFLOT)	DMATX (1,N)	= TRR	.95
	DMATX (2,N)	= TSS of OS1	40000.
	DMATX (3,N)	= GTH	1150.
	DMATX (4,N)	= GSTH	48.
	DMATX (5,N)	= HPWK	100.
	DMATX (6,N)	= DPOLY	10.
	DMATX (7,N)	= CPOLY	.45
	DMATX (16,N)	= ECF	2.
Multiple Hearth Incineration (MHINC)	DMATX (1,N)	= ML	2.
	DMATX (2,N)	= NINC	1.
	DMATX (3,N)	= HPWK	35.
	DMATX (4,N)	= SPER	5.
	DMATX (5,N)	= WV	0.

DMATX INPUTS WITH NOMINAL VALUES (Cont'd)

Multiple Hearth Incineration (MHINC) (Cont'd)	DMATX (6,N) = HV	10000.
	DMATX (7,N) = TYPE	1.
	DMATX (8,N) = FC	.14
	DMATX (9,N) = CNG	.97
	DMATX (16,N) = ECF	1.
Raw Wastewater Pumping (RWP)	DMATX (1,N) = HEAD	30.
	DMATX (16,N) = ECF	1.
Sludge Holding Tanks (SHT)	DMATX (1,N) = TD	15.
	DMATX (16,N) = ECF	1.
Centrifugation (CENT)	DMATX (1,N) = CRR	.95
	DMATX (2,N) = TSS of OS1	200000.
	DMATX (3,N) = HPWK	35.
	DMATX (4,N) = XCEN	1.
	DMATX (5,N) = POLY	2.
	DMATX (6,N) = CPOLY	2.
	DMATX (16,N) = ECF	1.
Aerobic Digestion (AEROB)	DMATX (1,N) = XL	-
	DMATX (2,N) = XAFS	1.
	DMATX (3,N) = DTA	30.
	DMATX (4,N) = TSS1	40000.
	DMATX (5,N) = TSS2	150.
	DMATX (6,N) = BOD2	50.
	DMATX (7,N) = GSS	150.

DMATX INPUTS WITH NOMINAL VALUES (Cont'd)

Aerobic Digestion (AEROB) (Cont'd)	DMATX (8,N)	= HEAD	30.
	DMATX (13,N)	= ECF of final settler	1.2
	DMATX (14,N)	= ECF of sludge return pumps	1.25
	DMATX (15,N)	= ECF of blowers	1.5
	DMATX (16,N)	= ECF of aeration tanks	1.2
Post Aeration (POSTA)	DMATX (1,N)	= ITYPE	-1.
	DMATX (2,N)	= L	-
	DMATX (3,N)	= DOIN	1.
	DMATX (4,N)	= DOUT	4.
	DMATX (5,N)	= TL	20.
	DMATX (6,N)	= TD	15.
	DMATX (7,N)	= TW	24.
	DMATX (8,N)	= AERFO	.08
	DMATX (9,N)	= HPHRO	3.5
	DMATX (10,N)	= ALT	0.
	DMATX (11,N)	= CFMDF	15.
	DMATX (12,N)	= DIFFT	1.
	DMATX (13,N)	= DD	13.
	DMATX (15,N)	= ECF of air supply system	1.
	DMATX (16,N)	= ECF of aeration basin	1.

DMATX INPUTS WITH NOMINAL VALUES (Cont'd)

Equalization (EQUAL)	DMATX (1,N)	= IAER	1.
	DMATX (2,N)	= RLW	1.
	DMATX (3,N)	= COSTL	.5
	DMATX (4,N)	= HEAD	10.
	DMATX (5,N)	= IMAT	0.
	DMATX (14,N)	= ECF of pumping system	1.25
	DMATX (15,N)	= ECF of surface aerators	1.
	DMATX (16,N)	= ECF of equalization basin	1.
Second Stage Anaerobic Digestion (DIG2)	DMATX (1,N)	= TRR	.81
	DMATX (2,N)	= TSS of OS1	50000.
	DMATX (3,N)	= TD	15.
	DMATX (16,N)	= ECF	1.
Land Disposal of Liquid Sludge (LANDD)	DMATX (1,N)	= TAYR	15.
	DMATX (2,N)	= SP	.25
	DMATX (3,N)	= DIST	10.
	DMATX (4,N)	= TS	1200.
	DMATX (5,N)	= YRSL	6.
	DMATX (15,N)	= ECF of trucking capacity	1.
	DMATX (16,N)	= ECF of sludge holding lagoon	1.
Lime Addition to Sludge (LIME)	DMATX (1,N)	= DLIME	200.
	DMATX (2,N)	= CLIME	25.

DMATX INPUT DEFINITIONS

COST - CCI - sewage treatment plant construction cost index to account for the variation of construction cost with time, 1957-59 = 1.0

WPI - wholesale price index for industrial commodities to account for the variation of materials and supplies cost with time, 1957-59 = 1.0

RI - amortization interest rate, fraction

YRS - amortization period, years

DHR - wastewater treatment plant hourly labor rate, \$/hr

PCT - fraction of direct labor cost that is charged as indirect labor cost

DA - cost of land, \$/acre

CCINT - interest rate for interest cost during plant construction, fraction

XLAB - type of plant laboratory, 1 = activated sludge, 0 = primary or trickling filter

CKWH - cost of electrical power, \$/kilowatt hour

PREL - IPREL - program control: 0 = grit removal and flow measurement, 1 = grit removal and flow measurement and screening

ECF - excess capacity factor

PRSET - FRPS - fraction of solids entering the primary settler which is removed from the main stream and sent to the thickener

URPS - ratio of solids concentration in OS2 from the primary settler to the solids concentration in IS1 to the primary settler

HPWK - hours per week that the primary sludge pumps are operated, hrs/wk

ECF - excess capacity factor (primary sludge pumps)

ECF - excess capacity factor (primary settler)

DMATX INPUT DEFINITIONS (Cont'd)

AERFS - BOD - demand value of 5-day BOD in the final effluent from the aeration process, mg/l

MLSS - total concentration of solids in the aerator, mg/l mass

DEGC - water temperature, degrees centigrade

CAER20 - rate constant used for sizing the aerator when the water temperature is 20°C

DO - concentration of dissolved oxygen in the aerator, mg/l oxygen

AEFF20 - efficiency of diffusers in the aerator at zero dissolved oxygen and 20°C

URSS - ratio of solids concentration in OS2 (underflow stream) from the aerator-final settler to the total solids concentration in the aerator

GSS - design overflow rate for the final settler, gpd/sq ft

HEAD - pumping head of sludge return pumps, feet

ALMD - dose of aluminum added to the aerator, mg/l

ECF - excess capacity factor (final settler)

ECF - excess capacity factor (sludge return pumps)

ECF - excess capacity factor (blowers)

ECF - excess capacity factor (aeration tanks)

MIX - NONE

SPLIT - NONE

DIG - TD - digester detention time, days

TDIG - sludge temperature in the digester, degrees centigrade

ECF - excess capacity factor

VACF - VFL - vacuum filter loading, gph/sq ft

DMATX INPUT DEFINITIONS (Cont'd)

VACF (Cont'd) - HPWK - hours per week that the vacuum filter is operated, hrs/wk

TSS - total suspended solids concentration of OS2, mg/l

IVACF - program control: 0 = landfill sludge disposal, 1 = incineration sludge disposal

FE - dose of iron added to condition sludge, lb/ton

CAO - dose of alum added to condition sludge, lb/ton

CFE - cost of adding iron, $/lb

CCAO - cost of adding alum, $/lb

ECF - excess capacity factor

THICK - TRR - solids recovery ratio for thickening

TSS - total suspended solids concentration of OS1, mg/l

GTH - design overflow rate for the thickener, gpd/sq ft

GSTH - design solids loading rate for the thickener, lb/day/sq ft

ECF - excess capacity factor

ELUT - ERR - solids recovery ratio for elutriation

TSS - total suspended solids concentration of OS1, mg/l

WRE - wash water ratio for elutriation

GE - design overflow rate for elutriation, gpd/sq ft

GES - design solids loading rate for elutriation, lb/day/sq ft

ECF - excess capacity factor

SBEDS - SBL - sludge bed loading, gph/sq ft

SOUT - percent solids of OS1

TSS - total suspended solids concentration of OS2, mg/l

ECF - excess capacity factor

DMATX INPUT DEFINITIONS (Cont'd)

TRFS - BOD - demand value of 5-day BOD in the final effluent from the trickling filter process, mg/l

DEGC - water temperature, degrees centigrade

HQ - trickling filter hydraulic loading, mg/acre

SAREA - trickling filter specific surface area, sq ft/cu ft

URSS - ratio of solids concentration in OS2 (underflow stream)

XRSS - ratio of solids concentration of OS1 (overflow stream) from the trickling filter - final settler to the total solids concentration in the filter

RECYCL - trickling filter recirculation number

GSS - design overflow rate for the final settler, gph/sq ft

HEAD - pumping head of the sludge return pumps, feet

ECF - excess capacity factor (sludge return pumps)

ECF - excess capacity factor (final settler)

ECF - excess capacity factor (filters)

CHLOR - DCL2 - dose of chlorine, mg/l

TCL2 - chlorine contract time, minutes

ECF - excess capacity factor (feed system)

ECF - excess capacity factor (contact basin)

TFLOT - TRR - solids recovery ratio for thickening

TSS - total suspended solids concentration of OS1, mg/l

GTH - design overflow rate for the thickener, gpd/sq ft

GSTH - design solids loading rate for the thickener, lb/day/sq ft

HPWK - hours per week that the thickener is operated, hrs/week

DPOLY - dose of polymer, lb/ton

DMATX INPUT DEFINITIONS (Cont'd)

TFLOT (Cont'd) - CPOLY - cost of polymer, $/lb

ECF - excess capacity factor

MHINC - ML - mass loading, lb/hr/sq ft of hearth area

NINC - number of multiple hearth incinerators

HPWK - hours per week that the incinerators are operated, hrs/wk

SPER - number of startup periods per week

WV - wind velocity, mph

HV - higher heat value for volatiles, BTU/lb

TYPE - type of fuel used: 1 = fuel oil, 2 = natural gas 3 = digester gas

FC - cost of fuel oil, $/gallon

CNG - cost of natural gas, $/1000 cu ft

ECF - excess capacity factor

RWP - HEAD - pumping head of influent pumps, feet

ECF - excess capacity factor

SHT TD - sludge holding tank detention time, days

ECF - excess capacity factor

CENT - CRR - solids recovery ratio for centrifugation

TSS - total suspended solids concentration of OS1, mg/l

HPWK - hours per week that the centrifuges are operated, hrs/wk

XCEN - program control: 0 = landfill sludge disposal, 1 = incineration sludge disposal

POLY - dose of polymer added to condition sludge, lb/ton

CPOLY - cost of adding polymer, $/lb

ECF - excess capacity factor

DMATX INPUT DEFINITIONS (Cont'd)

AEROB - XL - program control: this input variable is set equal to the process number (N) given to the aeration (AERFS) process to allow the AEROB subroutine to use output parameters calculated in the aeration process

XAFS - program control: 0 = no final settler and sludge return pumps are required, 1 = a final settler and sludge return pumps are required with the aerobic digestion process

DTA - detention time for the aeration, days

TSS1 - total suspended solids in OS1, mg/l

TSS2 - total suspended solids in OS2, mg/l

BOD2 - 5-day BOD concentration in OS2, mg/l

GSS - overflow rate for the final sedimentation, gpd/sq ft

HEAD - pumping head of the sludge return pumps, feet

ECF - excess capacity factor (final settler)

ECF - excess capacity factor (sludge return pumps)

ECF - excess capacity factor (blowers)

ECF - excess capacity factor (aeration tanks)

POSTA - ITYPE - program control: -1 = mechanical aeration system is used, 0 = diffused air aeration system is used (plug flow), +1 = diffused air aeration system is used (complete mix)

L - program control: set equal to the process number (N) given to the aeration (AERFS) process to allow the POSTA subroutine to use output parameters calculated in the aeration process

DOIN - dissolved oxygen concentration entering the post aeration process, mg/l

DOUT - dissolved oxygen concentration in the effluent stream from the post aeration process, mg/l

DMATX INPUT DEFINITIONS (Cont'd)

POSTA - TL - water temperature, degrees centigrade
(Cont'd)

TD - tank depth (for diffused air only), feet

TW - tank width (for diffused air only), feet

AERFO - aeration efficiency at standard conditions (for diffused air only), fraction

HPHRO - efficiency measure for mechanical aerators, lbs. of oxygen transferred per hp-hour

ALT - altitude of plant site above sea level, feet

CFMDF - standard cubic feet of air per minute per diffuser

DIFFT - diffuser per foot of tank length

DD - depth of diffuser below the water surface, feet

ECF - excess capacity factor (air supply system)

ECF - excess capacity factor (aeration basin)

EQUAL - IAER - program control: 0 = small impeller mechanical aerators on floating platforms are used, 1 = large impeller mechanical aerators on stationary platforms are used

RLW - ratio of length to width for the equalization basin

COSTL - cost of pond lining material, dollars/sq ft

HEAD - pumping head of effluent pumps from the equalization basin process, feet

IMAT - program control: 0 = earthen pond with mechanical aeration is used for the equalization basin, 1 = concrete tank with diffused air is used for the equalization basin

ECF - excess capacity factor (pumping system)

ECF - excess capacity factor (surface aerators)

ECF - excess capacity factor (equalization basin)

DMATX INPUT DEFINITIONS (Cont'd)

DIG2 - TRR - solids recovery ratio for second stage anaerobic digestion

TSS - total suspended solids concentration of OS1, mg/l

TD - second stage anaerobic digester detention time, days

ECF - excess capacity factor

LANDD - TAYR - amount of dry solids disposal, tons/acre/year

SP - sludge storage period before disposal, years

DIST - round trip sludge hauling distance by truck, miles

TS - sludge loading capacity of trucks used for hauling, gallons

YRSL - amortization period for trucks, years

ECF - excess capacity factor (trucking capacity)

ECF - excess capacity factor (sludge holding lagoon)

LIME - DLIME - dose of lime, lbs of CaO/ton of dry solids

CLIME - cost of lime, dollars/ton of CaO

OMATX OUTPUT PARAMETERS

Cost (COST)	OMATX (1,20) = RATIO
	OMATX (2,20) = TCAP
	OMATX (3,20) = YARD
	OMATX (4,20) = TCC
	OMATX (5,20) = XLAND
	OMATX (6,20) = ENG
	OMATX (7,20) = SUBT1
	OMATX (8,20) = FISC
	OMATX (9,20) = SUBT2
	OMATX (10,20) = XINT
	OMATX (11,20) = ACRE
	OMATX (12,20) = AF
	OMATX (17,20) = TOT
	OMATX (18,20) = TAMM
	OMATX (19,20) = TOPER
	OMATX (20,20) = TOTAL
Preliminary Treatment (PREL)	NONE
Primary Sedimentation (PRSET)	OMATX (1,N) = GPS
	OMATX (2,N) = APS
	OMATX (3,N) = PGPM
Aerator - Final Settler (AERFS)	OMATX (1,N) = BOD2
	OMATX (2,N) = DOSAT
	OMATX (3,N) = XRSS
	OMATX (4,N) = AFS

OMATX OUTPUT PARAMETERS (Cont'd)

Aerator - Final Setter (AERFS) (Cont'd)

OMATX (5,N) = CAER
OMATX (6,N) = CEDR
OMATX (7,N) = VAER
OMATX (8,N) = VNIT
OMATX (9,N) = MLASS (XMLAS)
OMATX (10,N) = MLBSS (XMLBS)
OMATX (11,N) = MLNBSS (XMLNB)
OMATX (12,N) = MLDSS (XMLDS)
OMATX (13,N) = MLISS (XMLIS)
OMATX (14,N) = FOOD
OMATX (15,N) = RTURN
OMATX (16,N) = CNIT
OMATX (17,N) = ARCFD
OMATX (18,N) = BSIZE
OMATX (19,N) = CFPGL
OMATX (20,N) = QR

Stream Mixer (MIX)

NONE

Stream Splitter (SPLIT)

NONE

Anaerobic Digestion (DIG)

OMATX (1,N) = C1DIG
OMATX (2,N) = C2DIG
OMATX (3,N) = VDIG
OMATX (4,N) = CH4
OMATX (5,N) = CO2

OMATX OUTPUT PARAMETERS (Cont'd)

Vacuum Filtration (VACF)	OMATX (1,N) = WP
	OMATX (2,N) = AVF
	OMATX (3,N) = PSDD
Gravity Thickening (THICK)	OMATX (1,N) = ATHM
	OMATX (2,N) = WRT
Elutriation (ELUT)	OMATX (1,N) = AE
Sludge Drying Beds (SBEDS)	OMATX (1,N) = ASB
Trickling Filter - Final Settler (TRFS)	OMATX (1,N) = AFS
	OMATX (2,N) = VOL
	OMATX (3,N) = FAREA
	OMATX (4,N) = DEPTH
Chlorination (CHLOR)	NONE
Air Flotation Thickening (TFLOT)	OMATX (1,N) = ATHM
	OMATX (2,N) = XN
	OMATX (3,N) = ATHM1
Multiple Hearth Incineration (MHINC)	OMATX (1,N) = FHA
	OMATX (2,N) = WFYR
	OMATX (3,N) = PSDD
	OMATX (4,N) = ECOST
	OMATX (5,N) = FCOST
Raw Wastewater Pumping (RWP)	OMATX (1,N) = QP
Sludge Holding Tanks (SHT)	OMATX (1,N) = VSHT
	OMATX (2,N) = QP
Centrifugation (CENT)	OMATX (1,N) = CGPM

OMATX OUTPUT PARAMETERS (Cont'd)

Centrifugation (CENT) (Cont'd)

OMATX (2,N) = DSOL
OMATX (3,N) = AFC

Aerobic Digestion (AEROB)

OMATX (1,N) = VAER
OMATX (2,N) = ACFM
OMATX (3,N) = QPUMP
OMATX (4,N) = AFS

Post Aeration (POSTA)

OMATX (1,N) = VAER
OMATX (2,N) = CFM
OMATX (3,N) = HP
OMATX (4,N) = TMIN
OMATX (5,N) = VMG
OMATX (6,N) = AERFF
OMATX (7,N) = CLEN
OMATX (8,N) = HP1
OMATX (9,N) = XN
OMATX (10,N) = THP
OMATX (11,N) = WIDTH
OMATX (12,N) = DEPTH
OMATX (13,N) = TLEN

Equalization (EQUAL)

OMATX (1,N) = WIDTH
OMATX (2,N) = AREA
OMATX (3,N) = VUMG
OMATX (4,N) = VOMG
OMATX (5,N) = VT

OMATX OUTPUT PARAMETERS (Cont'd)

Equalization (EQUAL) (Cont'd)	OMATX (6,N) = SAREA
	OMATX (7,N) = HP
	OMATX (8,N) = HP1
	OMATX (9,N) = XN
	OMATX (10,N) = THP
	OMATX (11,N) = PLAND
	OMATX (12,N) = CLAND
	OMATX (13,N) = VAER
	OMATX (14,N) = ECFM
Second Stage Anaerobic Digestion (DIG2)	OMATX (1,N) = VDIG
Land Disposal of Liquid Sludge (LANDD)	OMATX (1,N) = TYT
	OMATX (2,N) = TTYR
	OMATX (3,N) = TRKN
	OMATX (4,N) = SLV
	OMATX (5,N) = TONS
	OMATX (6,N) = ALAND
	OMATX (7,N) = DLAND
	OMATX (8,N) = COL
	OMATX (9,N) = AFT
Lime Addition to Sludge (LIME)	OMATX (1,N) = PPDL
	OMATX (2,N) = DTON

OMATX OUTPUT DEFINITIONS

COST - RATIO - multiplier used to factor into individual unit process construction costs the costs of yardwork, land, engineering, legal and fiscal, and interest during construction, (TOT/TCAP)

TCAP - total capital cost of the entire system without yardwork, land, engineering, legal and fiscal, and interest during construction costs factored in, dollars

YARD - capital cost of yardwork, dollars

TCC - subtotal (TCAP + YARD), dollars

XLAND - cost of required land for plant construction, dollars

ENG - cost of engineering services for plant construction, dollars

SUBT1 - subtotal (TCAP + YARD + XLAND + ENG), dollars

FISC - cost of legal, fiscal and administrative services during plant construction, dollars

SUBT2 - subtotal (TCAP + YARD + XLAND + ENG + FISC), dollars

XINT - cost of interest during construction, dollars

ACRE - total land requirement for the entire plant, acres

AF - amortization factor

TOT - total capital cost of the entire plant (SUBT2 + XINT), dollars

TAMM - total amortization cost of the entire system, ¢/1000 gallons

TOPER - total operation and maintenance cost of the entire system, ¢/1000 gallons

TOTAL - total treatment cost (TAMM + TOPER) of the entire system, ¢/1000 gallons

PREL - NONE

OMATX OUTPUT DEFINITIONS (Cont'd)

PRSET - GPS - overflow rate for the primary settler, gpd/sq ft

APS - surface area of the primary settler, sq ft/1000

PGPM - firm pumping capacity of the primary sludge pumps, gpm

AERFS - BOD2 - influent 5-day BOD to the aeration process, mg/l

DOSAT - saturation value for dissolved oxygen in the aerator at one-half the water depth, mg/l oxygen

XRSS - ratio of solids concentration of OS1 (overflow) stream from the aerator-final settler to the total solids concentration in the aerator

AFS - surface area of the final settler, sq ft/1000

CAER - rate constant for sizing the aerator corrected for water temperature

CEDR - rate at which active solids are destroyed by natural causes in the aerator, fraction per day mass

VAER - volume of the aerator, millions of gallons

VNIT - volume of the aerator required to achieve nitrification, millions of gallons

MLASS (XMLAS) - concentration of active solids held in the aerator, mg/l mass

MLBSS (XMLBS) - concentration of unmetabolized biodegradable solids held in the aerator, mg/l mass

MLNBSS (XMLNB) - concentration of non-biodegradable organic solids in the aerator, mg/l mass

MLDSS (XMLDS) - concentration of non-biodegradable solids in the aerator caused by destruction of active solids by natural causes, mg/l mass

MLISS (XMLIS) - concentration of inert inorganic solids in the aerator caused by inorganic solids in the influent stream, mg/l mass

OMATX OUTPUT DEFINITIONS (Cont'd)

AERFS (Cont'd)	- FOOD	- 5-day BOD synthesized to active solids in the aerator each day, mg/l oxygen
	RTURN	- sludge return ratio for the aerator
	CNIT	- rate constant used in the nitrification calculation
	ARCFD	- air requirements for the aerator, scf/day
	BSIZE	- required size of the blower for supplying air to the aerator, cfm
	CFPGL	- air requirements for the aerator, scf/gallon of sewage entering the system
	QR	- volume of the return sludge stream, mgd
MIX	- NONE	
SPLIT	- NONE	
DIG	- C1DIG	- rate constant for the digester
	C2DIG	- rate constant for the digester
	VDIG	- volume of the digester, cu ft/1000
	CH4	- standard cubic feet of methane produced in the digester each day, scf/day methane
	CO2	- standard cubic feet of carbon dioxide produced in the digester each day, scf/day carbon dioxide
VACF	- WP	- percentage of moisture in the filtered sludge
	AVF	- surface area of the vacuum filter, sq ft
	PSDD	- amount of dry solids produced by the vacuum filter, lb/day
THICK	- ATHM	- surface area of the gravity thickener, sq ft
	WRT	- ratio of dilution stream flow in mgd/influent sludge stream flow in mgd
ELUT	- AE	- surface area of the elutriation tank, sq ft
SBEDS	- ASB	- area of the sludge drying beds, sq ft

OMATX OUTPUT DEFINITIONS (Cont'd)

TRFS - AFS - surface area of the final settler, sq ft/1000
VOL - trickling filter total volume, cu ft
FAREA - area of the face of the filter, sq ft
DEPTH - depth of the trickling filter

CHLOR - NONE

TFLOT - ATHM - surface area of each flotation thickener used, sq ft
XN - number of flotation thickeners used
ATHM1 - total required surface area for flotation thickening, sq ft

MHINC - FHA - total hearth area, sq ft
WFYR - total fuel usage, lb/year
PSDD - dry solids to be incinerated, lbs/day
ECOST - cost of electrical power to operate the incinerator, dollars/year
FCOST - cost of fuel to operate the incinerator, dollars/year

RWP - QP - peak flow capacity of the raw wastewater pumping system, mgd

SHT - VSHT - volume of the sludge holding tanks, cu ft/1000
QP - peak sludge flow capacity of the sludge holding tanks, mgd

CENT - CGPM - design capacity of the centrifuges, gpm
DSOL - dry solids coming out of the centrifuges, tons/year
AFC - amortization factor for centrifuges (based on a 10 year lifetime)

AEROB - VAER - volume of the aerator, cu ft/1000
ACFM - required size of the blower for supplying air to the aerator, cfm
QPUMP - volume of the return stream flow to the aerator, mgd

OMATX OUTPUT DEFINITIONS (Cont'd)

AEROB - AFS - surface area of the final settler, sq ft/1000
(Cont'd)

POSTA - VAER - volume of the post aeration basin, cu ft/1000

CFM - air requirement for the diffusers, cfm

HP - installed brake horsepower for mechanical aerator, hp

TMIN - post aeration basin detention time, minutes

VMG - volume of the post aeration basin, mg

AERFF - aeration efficiency corrected to plant conditions

CLEN - aeration channel length (plug flow), feet

HP1 - installed brake horsepower (HP) rounded off to the next higher available size mechanical aerator, hp

XN - number of mechanical aerators required

THP - total mechanical aeration horsepower required (HP1*XN), hp

WIDTH - mechanical aeration basin width, feet

DEPTH - mechanical aeration basin depth, feet

TLEN - aeration basin length (diffused air, complete mix), feet

EQUAL - WIDTH - equalization basin width at the water line, feet

AREA - equalization basin area at the water surface, acres

VUMG - usable liquid volume for the equalization basin, mg

VOMG - minimum liquid volume for the equalization basin, mg

VT - total liquid volume of the equalization basin (VUMG + VOMG), mg

SAREA - area of equalization basin lining required, sq ft

HP - mechanical aerator brake horsepower, hp

OMATX OUTPUT DEFINITIONS (Cont'd)

EQUAL (Cont'd) HP1 - brake horsepower (HP) rounded off to the next higher available size mechanical aerator, hp

XN - number of mechanical aerators required

THP - total mechanical aeration brake horsepower required (HP1*XN), hp

PLAND - amount of land needed for the equalization basin, acres (Note that this land area requirement is included in the total land area requirement (ACRE) for the whole plant)

CLAND - cost of land needed for the equalization basin, dollars (Note that this cost is included in the total plant cost (XLAND) for land)

VAER - volume of the concrete tank used for the equalization basin, cu ft/1000

ECFM - required size of the blower for supplying air to the concrete equalization basin, cfm

DIG2 - VDIG - volume of the second stage anaerobic digesters, cu ft/1000

LANDD - TYT - total number of trips made per year by each truck

TTYR - total number of trips made per year by all the trucks

TRKN - total number of trucks needed to haul the sludge

SLV - volume of sludge produced, cu ft/1000

TONS - amount of dry solids applied to the land, tons/year

ALAND - required land area for spreading the sludge, acres

DLAND - interest cost on the capital investment in land for sludge spreading, dollars/year

LANDD - COL - capital cost of land area required for sludge spreading, dollars

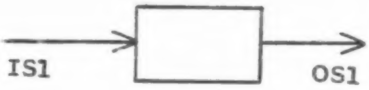
AFT - amortization factor for trucks

LIME - PPDL - lime addition rate, lbs (CaO)/day

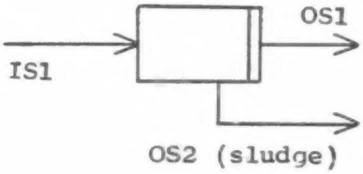
DTON - amount of sludge to be treated with lime, tons/day of dry solids

EXECUTIVE PROGRAM PROCESS SYMBOLS WITH STREAM DESIGNATIONS

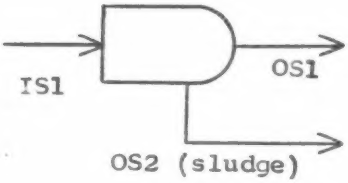
Preliminary Treatment
(PREL)



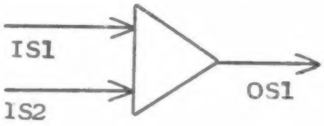
Primary Sedimentation (PRSET)


OS1
IS1
OS2 (sludge)

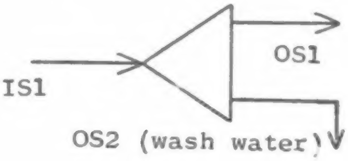
Aerator-Final
Settler (AERFS)


IS1
OS1
OS2 (sludge)

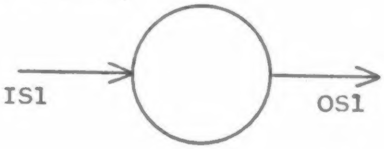
Stream Mixer (MIX)



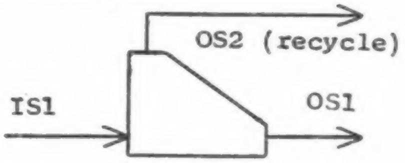
Stream Splitter (SPLIT)


OS1
IS1
OS2 (wash water)

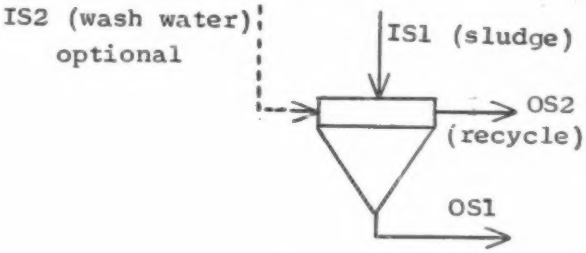
Anaerobic Digestion (DIG)



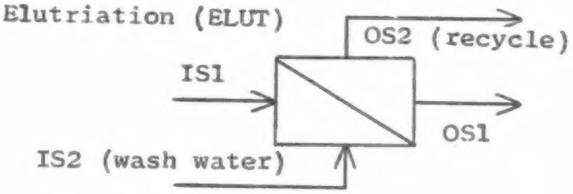
Vacuum Filtration (VACF)


OS2 (recycle)
IS1
OS1

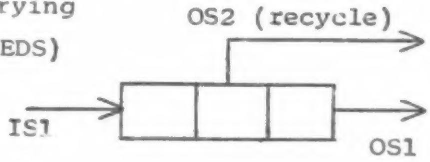
Gravity Thickening (THICK)


IS2 (wash water)
optional
IS1 (sludge)
OS2
(recycle)
OS1

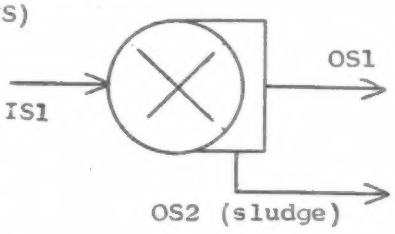
Elutriation (ELUT)


OS2 (recycle)
IS1
OS1
IS2 (wash water)

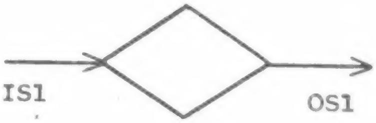
Sludge Drying
Beds (SBEDS)


OS2 (recycle)
IS1
OS1

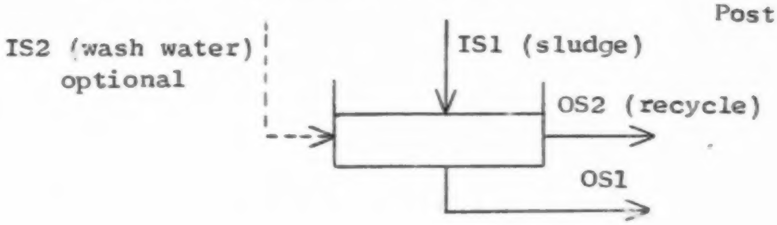
Trickling Filter-Final
Settler (TRFS)


OS1
IS1
OS2 (sludge)

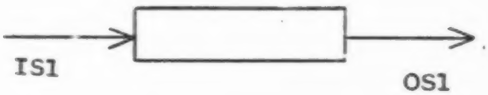
Chlorination (CHLOR)



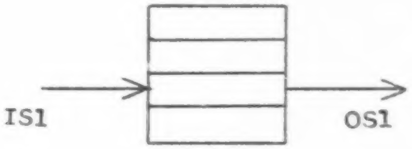
Flotation Thickening (TFLOT)


IS2 (wash water)
optional
IS1 (sludge)
OS2 (recycle)
OS1

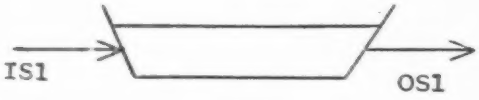
Post Aeration (POSTA)



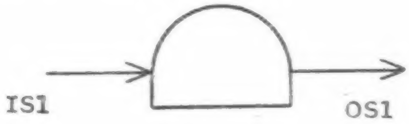
Multiple Hearth Incineration (MHINC)



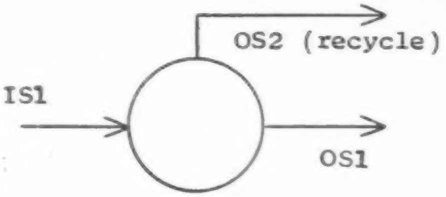
Equalization Pond (EQUAL)



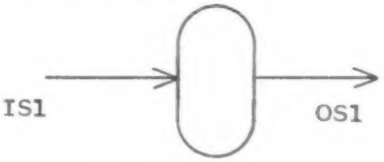
Raw Wastewater Pumping (RWP)



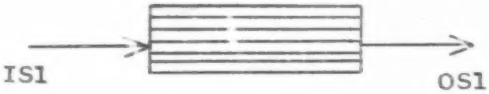
Second Stage Anaerobic Digestion (DIG2)


OS2 (recycle)
IS1
OS1

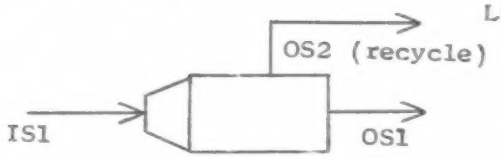
Sludge Holding Tanks (SHT)



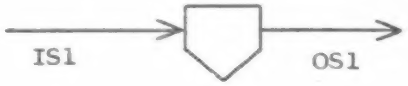
Land Disposal of Liquid Sludge (LANDD)



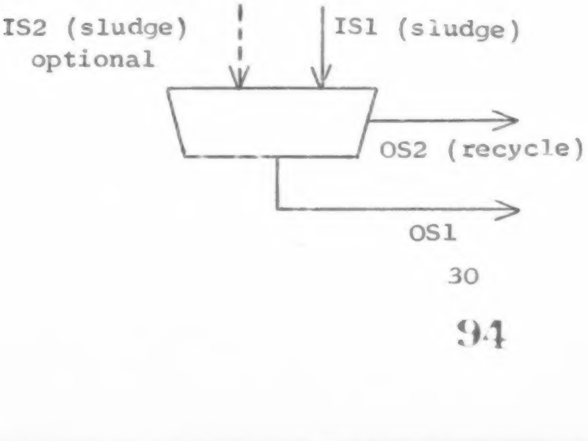
Centrifugation (CENT)


OS2 (recycle)
IS1
OS1

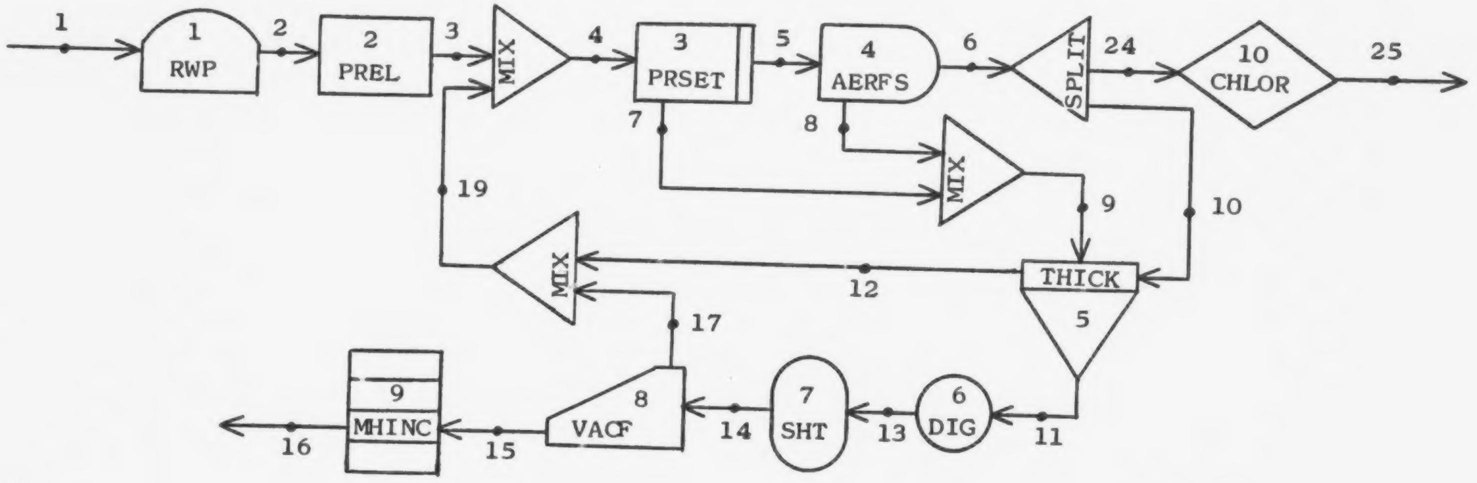
Lime Addition to Sludge (LIME)



Aerobic Digestion (AEROB)


IS2 (sludge)
optional
IS1 (sludge)
OS2 (recycle)
OS1

EXECUTIVE PROGRAM
Standard Test System Diagram Number 1


1
1 RWP
2
2 PREL
3
MIX
4
3 PRSET
5
4 AERFS
6
SPLIT
24
10 CHLOR
25
7
8
MIX
19
9
10
MIX
12
THICK
5
17
9 MHINC
8 VACF
7 SHT
6 DIG
16
15
14
13
11

INPUT DATA

K	N	Process	IS1	IS2	OS1	OS2	III
0	1	15 RWP	1	0	2	0	2
0	2	1 PREL	2	0	3	0	2
1	0	4 MIX	3	19	4	0	1
0	3	2 PRSET	4	0	5	7	0
0	4	3 AERFS	5	0	6	8	0
0	0	5 SPLIT	6	0	24	10	0
0	0	4 MIX	7	8	9	0	0
0	5	8 THICK	9	10	11	12	0
0	6	6 DIG	11	0	13	0	0
0	7	16 SHT	13	0	14	0	0
0	8	7 VACF	14	0	15	17	0
1	0	4 MIX	12	17	19	0	1
0	9	14 MHINC	15	0	16	0	2
0	10	12 CHLOR	24	0	25	0	2
9							

DATA CARD INPUT

```
     10 MGD        EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 1
   1   1                                                 .1
       10.      105.       30.       10.        2.       30.      140.      224.
      254.       43.       11.       19.        4.      500.      250.       60.
     1.506     1.122       .06       25.      3.50       .15     1000.       .06
        1.      .015
0  1  15 RWP       1         0         2         0                             2
       30.

                                                                              1.
0  2   1 PREL      2         0         3         0                             2
        1.

                                                                              1.
1  0   4 MIX       3        19         4         0                             1
0  3   2 PRSET     4         0         5         7                             0
        .5      400.       14.

                                                                    1.       1.2
0  4   3 AERFS     5         0         6         8                             0
       13.     2000.       20.        1.        1.       .05        3.      700.
       30.        0.                           1.2        1.        1.       1.2
0  0   5 SPLIT     6         0        24        10                             0
0  0   4 MIX       7         8         9         0                             0
0  5   8 THICK     9        10        11        12                             0
       .95    50000.      700.        8.

                                                                             1.5
0  6   6 DIG      11         0        13         0                             0
       15.       30.

                                                                             1.3
0  7  16 SHT      13         0        14         0                             0
       15.

                                                                              1.
0  8   7 VACF     14         0        15        17                             0
       4.9       35.      200.        1.       42.      176.      .064     .0125
                                                                              1.
1  0   4 MIX      12        17        19         0                             1
0  9  14 MHINC    15         0        16         0                             2
        2.        1.       35.        5.        0.    10000.        1.       .14
       .97                                                                    1.
0 10  12 CHLOR    24         0        25         0                             2
        8.       30.

                                                                   1.5       1.2
9
```

```
                              EXECUTIVE
                       DIGITAL COMPUTER PROGRAM
                                 FOR
           PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

                                 BY
                            ROBERT SMITH
                          RICHARD G. EILERS

                 U.S. ENVIRONMENTAL PROTECTION AGENCY
           ADVANCED WASTE TREATMENT RESEARCH LABORATORY
                         CINCINNATI, OHIO



 10 MGD       EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 1

                            SYSTEM DIAGRAM
                              INPUT DATA

 K     N     PROCESS         IS1      IS2      OS1      OS2      III

 0     1    15  RWP           1        0        2        0        2
 0     2     1  PREL          2        0        3        0        2
 1     0     4  MIX           3       19        4        0        1
 0     3     2  PRSET         4        0        5        7        0
 0     4     3  AERFS         5        0        6        8        0
 0     0     5  SPLIT         6        0       24       10        0
 0     0     4  MIX           7        8        9        0        0
 0     5     8  THICK         9       10       11       12        0
 0     6     6  DIG          11        0       13        0        0
 0     7    16  SHT          13        0       14        0        0
 0     8     7  VACF         14        0       15       17        0
 1     0     4  MIX          12       17       19        0        1
 0     9    14  MHINC        15        0       16        0        2
 0    10    12  CHLOR        24        0       25        0        2
 9     0     0                0        0        0        0        0
```

```
                         STREAM CHARACTERISTICS

                                              VOLUME FLOW, MILLIONS OF GALLONS PER DAY
                                              CONCENTRATIONS, MILLIGRAMS PER LITER

S 1.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
       10.000    105.000     30.000     10.000      2.000     30.000    140.000    224.000
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      250.000     43.000     11.000     19.000      4.000    500.000     60.000    254.000

S 2.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
       10.000    105.000     30.000     10.000      2.000     30.000    140.000    224.000
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      250.000     43.000     11.000     19.000      4.000    500.000     60.000    254.000

S 3.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
       10.000    105.000     30.000     10.000      2.000     30.000    140.000    224.000
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      250.000     43.000     11.000     19.000      4.000    500.000     60.000    254.000

S 4.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
       11.782     93.393     27.031      8.974      1.762     26.971    123.955    199.729
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      263.971     39.101     10.999     22.738      4.882    499.999     52.685    226.701

S 5.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
       11.767     46.754     13.532      4.493      0.882     13.502     62.055     99.989
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      263.971     39.101     10.999     22.738      4.882    499.999     52.685    113.492

S 6.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
       11.585      5.781      2.338      0.797      0.057      1.963      6.688     13.760
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      263.971     14.373     10.999     21.750      5.367    499.999      6.307     15.723

S 7.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.014  37357.203  10812.584   3589.945    704.803  10788.796  49582.312  79891.840
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      263.971     39.101     10.999     22.738      4.882    499.999     52.685  90680.422

S 8.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.181   2208.840    893.405    304.506     22.088    750.144   2555.523   5257.039
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      263.971     14.373     10.999     21.750      5.367    499.999      6.307   6007.183

S 9.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.196   4846.972   1637.910    551.101     73.330   1503.615   6085.215  10858.890
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      263.971     16.229     10.999     21.824      5.330    499.999      9.788  12362.505
```

```
S10.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         1.590      5.781       2.338      0.797      0.057      1.963       6.688      13.760
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
       263.971     14.373      10.999     21.750      5.367    499.999       6.307      15.723

S11.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         0.046  19591.089    6632.787   2232.041    295.436   6083.012   24577.496   43917.000
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
       263.971     14.576      10.999     21.758      5.363    499.999       6.690   50000.007

S12.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         1.739     27.597       9.343      3.144      0.416      8.569      34.622      61.865
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
       263.971     14.576      10.999     21.758      5.363    499.999       6.690      70.435

S13.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         0.046   6977.895    6632.787    808.760    107.048   6083.012     645.352   16607.386
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
      3566.695    126.036      10.999    946.891    193.750    499.999     215.117   22690.398

S14.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         0.046   6977.895    6632.787    808.760    107.048   8556.265     645.352   16607.386
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
      3566.695    126.036      10.999    946.891    193.750    499.999     215.117   25163.648

S15.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         0.004  75690.000   71946.578   8772.709   1161.168  92810.750    7000.211  180142.125
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
     38688.336   1367.127     119.318  10271.041   2101.634   5423.553    2333.404  272952.938

S16.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         0.000      0.000       0.000      0.000      0.000      0.000       0.000       0.000
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
         0.000      0.000       0.000      0.000      0.000      0.000       0.000       0.000

S17.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         0.042     55.460      52.717      6.428      0.850     68.004       5.129     131.995
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
      3566.695    126.036      10.999    946.891    193.750    499.999     215.117     200.000

S19.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         1.782     28.259      10.373      3.222      0.426      9.980      33.922      63.530
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
       342.372     17.222      10.999     43.720      9.835    499.999      11.637      73.510

S24.       Q         SOC        SNBC        SON        SOP        SFM        SBOD        VSS
         9.995      5.781       2.338      0.797      0.057      1.963       6.688      13.760
          ALK        DOC        DNBC        DN         DP         DFM        DBOD        TSS
       263.971     14.373      10.999     21.750      5.367    499.999       6.307      15.723
```

```
S25.        Q        SOC       SNBC       SON        SOP       SFM       SBOD       VSS
          9.995     5.781      2.338     0.797      0.057      1.963      6.688     13.760
           ALK       DOC       DNBC       DN         DP        DFM       DBOD       TSS
        263.971    14.373     10.999    21.750      5.367    499.999      6.307     15.723
```

```
                          PROCESS CHARACTERISTICS

                                                CCOST = CAPITAL COST, DOLLARS
                                                COSTO = OPERATING + MAINTENANCE COST, CENTS/1000 GAL.
                                                ACOST = AMORTIZATION COST, CENTS/1000 GAL.
                                                TCOST = TOTAL TREATMENT COST, CENTS/1000 GAL.

P 1  RAW WASTEWATER    HEAD     QP                                       CCOST     COSTO     ACOST     TCOST      ECF
     PUMPING           30.00   14.80                                    475105.    0.310     1.018     1.328      1.00

P 2  PRELIMINARY      IPREL                                              CCOST     COSTO     ACOST     TCOST      ECF
     TREATMENT          1.0                                             144551.    0.412     0.309     0.722      1.00

P 3  PRIMARY           FRPS     URPS     HPWK     GPS      APS     FGPM
     SEDIMENTATION     0.50    400.0     14.0   1375.2   10.280    122.
                                                                         CCOST     COSTO     ACOST     TCOST      ECF
                                                              SETTLER   202871.    0.194     0.434     0.629      1.20

                                                              SLUDGE     62608.    0.217     0.134     0.352      1.00
                                                              PUMPS

P 4  AERATOR-           BOD     MLSS     DEGC   CAER20      DO    AEFF20    URSS      GSS      HEAD      ALMD
     FINAL SETTLER      13.0    2000.    20.00    1.00     1.00     0.05     3.00    700.00    30.00      0.00

                       BOD2    DOSAT     XRSS      AFS     CAER     CEDR     VAER      VNIT     MLASS     MLBSS
                       114.7    10.7   0.0078   19.86     1.00    0.124    2.302     2.609     511.      626.

                     MLNBSS    MLDSS    MLISS     FOOD    RTURN     CNIT    ARCFD     BSIZE     CFPGL       QR
                        533.      74.     250.     76.0    0.472    0.321  6947851.    4824.     0.59     5.565
                                                                         CCOST     COSTO     ACOST     TCOST      ECF
                                                              AERATOR   398945.    0.000     0.855     0.855      1.20

                                                              BLOWER    244726.    1.042     0.524     1.567      1.00

                                                              SLUDGE    105789.    0.223     0.226     0.449      1.00
                                                              PUMPS

                                                              FINAL     330043.    0.298     0.707     1.005      1.20
                                                              SETTLER

P 5  GRAVITY            TRR      TSS      GTH     GSTH     ATHM      WRT
     THICKENING         0.95   50000.    700.0     8.0    3827.7     8.10
                                                                         CCOST     COSTO     ACOST     TCOST      ECF
                                                                        107630.    0.098     0.230     0.329      1.50

P 6  ANAEROBIC          TD      TDIG    C1DIG    C2DIG     VDIG      CH4       CO2
     DIGESTION          15.0    30.0    0.233    1154.     121.    95382.    50092.

                                                                         CCOST     COSTO     ACOST     TCOST      ECF
```

```
                                                                354563.   0.259   0.759   1.018    1.30

P 7  SLUDGE HOLDING   TD      VSHT     QP                        CCOST    COSTO   ACOST   TCOST    ECF
     TANKS            15.0    212.4    0.10                      355197.  0.312   0.761   1.073    1.00

P 8  VACUUM           VFL     HPWK     TSS     IVACF    FE       CAO      CFE     CCAO
     FILTRATION       4.90    35.      200.    1.0      42.00    176.00   0.0640  0.0125

                      WP      AVF      PSDD                      CCOST    COSTO   ACOST   TCOST    ECF
                      78.5    1837.4   9760.                     1343241. 0.901   2.878   3.780    1.00

P 9  MULTIPLE HEARTH  ML      NINC     HPWK    SPER     WV       HV       TYPE    FC      CNG
     INCINERATION     2.0     1.0      35.0    5.0      0.0      10000.0  1.0     0.140   0.970

                      FHA     WFYR     PSDD    ECOST    FCOST    CCOST    COSTO   ACOST   TCOST    ECF
                      988.    284024.  9689.   1251.    5315.    523231.  0.599   1.121   1.720    1.00

P10  CHLORINATION     DCL2    TCL2                               CCOST    COSTO   ACOST   TCOST    ECF
                      8.0     30.0                      FEED     81817.   0.599   0.175   0.774    1.20
                                                        SYSTEM

                                                        CONTACT  86746.   0.000   0.185   0.185    1.50
                                                        BASIN

     ADMINISTRATIVE                                              CCOST    COSTO   ACOST   TCOST
     AND LABORATORY                                              147854.  0.410   0.316   0.727

     GARAGE                                                      CCOST    COSTO   ACOST   TCOST
     AND SHOP                                                    43754.   0.000   0.093   0.093

     LABORATORY       XLAB                                       CCOST    COSTO   ACOST   TCOST
     OPERATION        1.0                                        0.       0.473   0.000   0.473

     YARDWORK                                                    CCOST    COSTO   ACOST   TCOST
     OPERATION                                                   0.       0.257   0.000   0.257
```

```
                              TOTAL PLANT COST

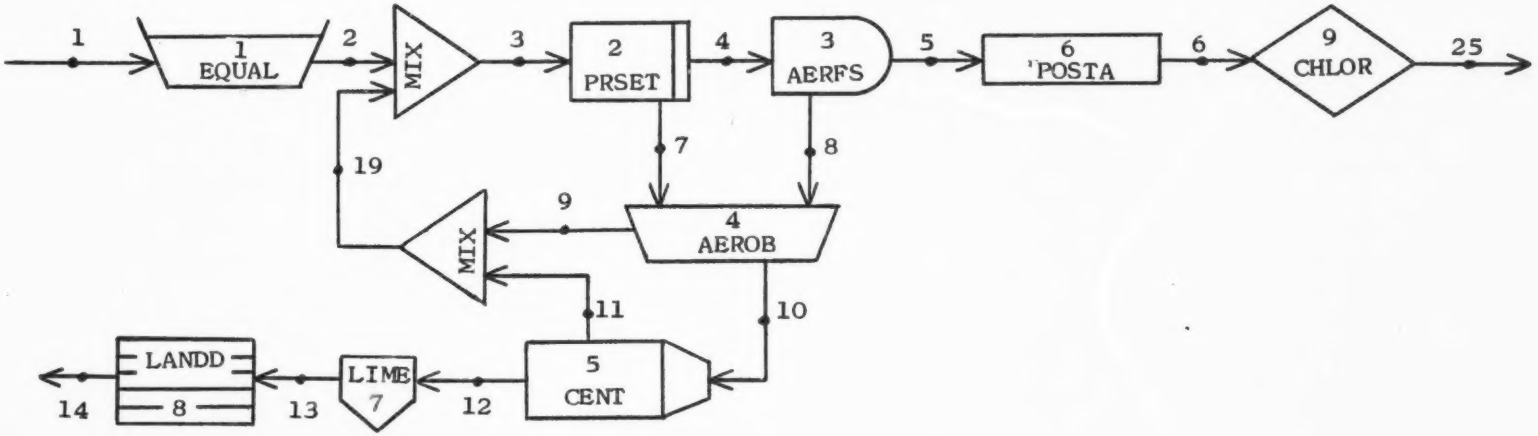
                 TOTAL CAPITAL COST =   5008678. DOLLARS
             TOTAL AMORTIZATION COST =     10.734 CENTS/1000 GAL.
                     TOTAL O + M COST =     6.610 CENTS/1000 GAL.
               TOTAL TREATMENT COST =     17.345 CENTS/1000 GAL.


   CCI        WPI        RI         YRS        DHR        PCT         DA        CCINT        XLAB        CKWH
   1.506      1.122      0.060      25.0       3.50       0.150      1000.       0.06        1.00       0.015


 RATIO       TCAP       YARD        TCC        XLAND       ENG       SUBT1       FISC       SUBT2        XINT
   1.334   3754294.    525601.   4279883.     19976.    370657.   4670513.     34432.   4704954.     303717.

  ACRE        AF
   19.97     0.07822
```

EXECUTIVE PROGRAM
Standard Test System Diagram Number 2


1
1 EQUAL
2
MIX
3
2 PRSET
4
3 AERFS
5
6 POSTA
6
9 CHLOR
25
7
8
19
9
4 AEROB
MIX
11
10
LANDD
8
14
13
LIME 7
12
5 CENT

INPUT DATA

K	N	Process	IS1	IS2	OS1	OS2	III
0	1	20 EQUAL	1	0	2	0	2
1	0	4 MIX	2	19	3	0	1
0	2	2 PRSET	3	0	4	7	0
0	3	3 AERFS	4	0	5	8	0
0	4	18 AEROB	8	7	10	9	0
0	5	17 CENT	10	0	12	11	0
1	0	4 MIX	9	11	19	0	1
0	6	19 POSTA	5	0	6	0	2
0	7	23 LIME	12	0	13	0	2
0	8	22 LANDD	13	0	14	0	2
0	9	12 CHLOR	6	0	25	0	2
9							

DATA CARD INPUT

```
     10 MGD        EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 2
   1   1             .                                  .1
       10.      105.       30.       10.        2.       30.      140.      224.
      254.       43.       11.       19.        4.      500.      250.       60.
     1.506     1.122       .06       25.      3.50       .15     1000.       .06
        1.      .015
0  1  20 EQUAL     1         0         2         0                             2
        1.        1.        .5       10.        0.
                                                      1.25        1.        1.
1  0   4 MIX       2        19         3         0                             1
0  2   2 PRSET     3         0         4         7                             0
        .5      400.       14.
                                                                    1.       1.2
0  3   3 AERFS     4         0         5         8                             0
       13.     2000.       20.        1.        1.       .05        3.      700.
       30.        0.                                 1.2        1.        1.       1.2
0  4  18 AEROB     8         7        10         9                             0
        3.        1.       30.    40000.      150.       50.      150.       30.
                                         1.2      1.25       1.5       1.2
0  5  17 CENT     10         0        12        11                             0
       .95   200000.       35.        0.        2.        2.
                                                                              1.
1  0   4 MIX       9        11        19         0                             1
0  6  19 POSTA     5         0         6         0                             2
       -1.        3.        1.        4.       20.       15.       24.       .08
       3.5        0.       15.        1.       13.                  1.        1.
0  7  23 LIME     12         0        13         0                             2
      200.       25.
                                                                              1.
0  8  22 LANDD    13         0        14         0                             2
       15.       .25       10.     1200.        6.
                                                                    1.        1.
0  9  12 CHLOR     6         0        25         0                             2
        8.       30.
                                                                   1.5       1.2
9
```

```
                              EXECUTIVE
                       DIGITAL COMPUTER PROGRAM
                                 FOR
           PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

                                  BY
                             ROBERT SMITH
                           RICHARD G. EILERS

                  U.S. ENVIRONMENTAL PROTECTION AGENCY
             ADVANCED WASTE TREATMENT RESEARCH LABORATORY
                           CINCINNATI, OHIO



 10 MGD        EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 2

                             SYSTEM DIAGRAM
                               INPUT DATA

 K     N     PROCESS         IS1        IS2        OS1        OS2        III

 0     1    20  EQUAL          1          0          2          0          2
 1     0     4  MIX            2         19          3          0          1
 0     2     2  PRSET          3          0          4          7          0
 0     3     3  AERFS          4          0          5          8          0
 0     4    18  AEROB          8          7         10          9          0
 0     5    17  CENT          10          0         12         11          0
 1     0     4  MIX            9         11         19          0          1
 0     6    19  POSTA          5          0          6          0          2
 0     7    23  LIME          12          0         13          0          2
 0     8    22  LANDD         13          0         14          0          2
 0     9    12  CHLOR          6          0         25          0          2
 9     0     0                 0          0          0          0          0
```

```
                         STREAM CHARACTERISTICS

                                        VOLUME FLOW, MILLIONS OF GALLONS PER DAY
                                        CONCENTRATIONS, MILLIGRAMS PER LITER

S 1.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
         10.000    105.000     30.000     10.000      2.000     30.000    140.000    224.000
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.000     43.000     11.000     19.000      4.000    500.000     60.000    254.000

S 2.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
         10.000    105.000     30.000     10.000      2.000     30.000    140.000    224.000
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.000     43.000     11.000     19.000      4.000    500.000     60.000    254.000

S 3.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
         10.191    105.836     32.241     10.092      1.990     31.535    138.199    225.774
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.937     44.198     11.796     25.461      5.064    500.000     58.875    257.309

S 4.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
         10.178     52.984     16.141      5.052      0.996     15.787     69.186    113.028
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.937     44.198     11.796     25.461      5.064    500.000     58.875    128.815

S 5.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
          9.994      5.460      2.295      0.752      0.054      1.911      6.156     12.995
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.937     15.457     11.796     24.298      5.609    500.000      6.847     14.907

S 6.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
          9.994      5.460      2.295      0.752      0.054      1.911      6.156     12.995
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.937     15.457     11.796     24.298      5.609    500.000      6.847     14.907

S 7.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
          0.012  42334.406  12896.671   4037.188    796.222  12614.210  55279.984  90309.656
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.937     44.198     11.796     25.461      5.064    500.000     58.875 102923.859

S 8.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
          0.183   2201.842    925.432    303.487     22.018    770.806   2482.387   5240.384
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        250.937     15.457     11.796     24.298      5.609    500.000      6.847   6011.189

S 9.        Q         SOC        SNBC        SON        SOP        SFM       SBOD        VSS
          0.167     52.152     52.152      5.215      0.521     38.914     50.000    111.085
           ALK        DOC        DNBC         DN         DP        DFM       DBOD        TSS
        300.000    106.955     53.477    363.765     60.793    500.000      0.000    150.000
```

```
S10.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        0.028    13907.421    13907.421     1390.742     139.074   10417.201      0.000   29622.804
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
      300.000      106.955       53.477      363.765       60.793     500.000      0.000   40040.007

S11.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        0.023      858.685      858.685       85.868        8.586     643.188      0.000    1828.999
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
      300.000      106.955       53.477      363.765       60.793     500.000      0.000    2472.188

S12.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        0.005    69467.640    69467.640     6946.762      694.676   52033.961      0.000  147966.031
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
      300.000      106.955       53.477      363.765       60.793     500.000      0.000  200000.031

S13.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        0.005    69467.640    69467.640     6946.762      694.676   72083.953      0.000  147966.031
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
      300.000      106.955       53.477      363.765       60.793     500.000      0.000  220050.000

S14.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        0.000        0.000        0.000        0.000        0.000       0.000      0.000       0.000
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
        0.000        0.000        0.000        0.000        0.000       0.000      0.000       0.000

S19.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        0.191      149.606      149.606       14.960        1.496     111.928     43.958     318.660
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
      300.000      106.955       53.477      363.765       60.793     499.999      0.000     430.589

S25.        Q          SOC         SNBC         SON          SOP         SFM         SBOD        VSS
        9.994        5.460        2.295        0.752        0.054       1.911      6.156      12.995
          ALK          DOC         DNBC           DN           DP         DFM        DBOD        TSS
      250.937       15.457       11.796       24.298        5.609     500.000      6.847      14.907
```

```
                              PROCESS CHARACTERISTICS

                                          CCOST = CAPITAL COST, DOLLARS
                                          COSTO = OPERATING + MAINTENANCE COST, CENTS/1000 GAL.
                                          ACOST = AMORTIZATION COST, CENTS/1000 GAL.
                                          TCOST = TOTAL TREATMENT COST, CENTS/1000 GAL.

P 1  EQUALIZATION       IAER      RLW    COSTL     HEAD     IMAT    WIDTH     AREA     VUMG     VOMG       VT
                         1.0      1.0    0.500     10.0      0.0   155.47   0.5548   1.1999   0.2449   1.4449

                       SAREA       HP      HP1       XN      THP    PLAND    CLAND     VAER     ECFM
                     36030.8    72.89    75.00      1.0    75.00     3.63    3632.    0.000       0.

                                                                    CCOST    COSTO    ACOST    TCOST      ECF.
                                                           AERATED  29447.    0.077    0.063    0.140     1.00
                                                           POND/TANK

                                                           AIR      94703.    0.231    0.202    0.434     1.00
                                                           SUPPLY

                                                           PUMPING 185263.    0.217    0.397    0.614     1.25
                                                           SYSTEM

                                                           FLOW     22795.    0.000    0.048    0.048
                                                           MEASURING

                                                           POND     24113.    0.000    0.051    0.051
                                                           LINING

P 2  PRIMARY            FRPS     URPS     HPWK      GRS      APS     PGPM
     SEDIMENTATION      0.50    400.0     14.0   1375.2    8.892     106.

                                                                    CCOST    COSTO    ACOST    TCOST      ECF
                                                           SETTLER 183896.    0.178    0.394    0.572     1.20

                                                           SLUDGE   58772.    0.203    0.125    0.329     1.00
                                                           PUMPS

P 3  AERATOR-            BOD     MLSS     DEGC   CAER20       DO   AEFF20     URSS      GSS     HEAD     ALMD
     FINAL SETTLER      13.0    2000.    20.00     1.00     1.00     0.05     3.00   700.00    30.00     0.00

                        BOD2    DOSAT     XRSS      AFS     CAER     CEDR     VAER     VNIT    MLASS    MLBSS
                       128.0     10.7   0.0074    17.13     1.00    0.124    2.252    2.509     509.     597.

                      MLNBSS    MLDSS    MLISS     FOOD    RTURN     CNIT    ARCFD    BSIZE    CFPGL       QR
                        559.      73.     256.     86.0    0.469    0.321 6794158.    4718.     0.66    4.776

                                                                    CCOST    COSTO    ACOST    TCOST      ECF
                                                           AERATOR 392546.    0.000    0.841    0.841     1.20

                                                           BLOWER  241632.    1.024    0.517    1.542     1.00

                                                           SLUDGE   96335.    0.207    0.206    0.414     1.00
                                                           PUMPS
```

```
                                                      FINAL     295848.    0.270    0.634    0.904     1.20
                                                      SETTLER

P 4  AEROBIC             XL     XAFS      DTA     TSS1     TSS2     BOD2      GSS     HEAD
     DIGESTION           3.       1.     30.0   40000.     150.     50.0   150.00    30.00

                       VAER     ACFM    QPUMP      AFS
                    945.345   28360.     0.36     1.57

                                                             CCOST    COSTO    ACOST    TCOST      ECF
                                                      AERATOR  1128849.    0.000    2.419    2.419     1.20

                                                      BLOWER    918134.    3.292    1.967    5.260     1.50

                                                      SLUDGE     26770.    0.088    0.057    0.145     1.25
                                                      PUMPS

                                                      FINAL      66748.    0.074    0.143    0.217     1.20
                                                      SETTLER

P 5  CENTRIFUGATION     CRR      TSS     HPWK     XCEN     POLY    CPOLY     CGPM     DSOL      AFC
                       0.95  200000.     35.0      0.0     2.00     2.00      94.   1734.7  0.13586

                                                             CCOST    COSTO    ACOST    TCOST      ECF
                                                            468840.    0.894    1.745    2.639     1.00

P 6  POST AERATION    ITYPE        L     DOIN     DOUT       TL       TD       TW    AERFO    HPHRO      ALT
                        -1.       3.      1.0      4.0     20.0     15.0     24.0    0.080     3.50     0.00

                      CFMDF    DIFFT       DD     VAER      CFM       HP     TMIN      VMG    AERFF     CLEN
                       15.0      1.0     13.0    2.430       0.     6.52     2.61   0.0181    0.000     0.00

                        HP1       XN      THP    WIDTH    DEPTH     TLEN
                       7.50      1.0     7.50     20.9      5.5     0.00

                                                             CCOST    COSTO    ACOST    TCOST      ECF
                                                      BASIN      16977.    0.000    0.036    0.036     1.00

                                                      AIR        26770.    0.142    0.057    0.199     1.00
                                                      SUPPLY

P 7  LIME ADDITION    DLIME    CLIME     PPDL     DTON                CCOST    COSTO    ACOST    TCOST      ECF
     TO SLUDGE        200.0    25.00    905.2     4.52                21284.    0.293    0.045    0.339     1.00

P 8  LAND DISPOSAL     TAYR       SP     DIST       TS     YRSL
                      15.00     0.25    10.00    1200.      6.0

                        TYT     TTYR     TRKN      SLV     TONS    ALAND    DLAND      COL      AFT
                       2311.    1648.       1.    66.12  1817.31   121.15    7269.  121154.  0.20336

                                                             CCOST    COSTO    ACOST    TCOST      ECF
                                                      STORAGE    13214.    0.018    0.028    0.046     1.00
                                                      LAGOON

                                                      TRUCKING    8098.    0.267    0.045    0.312     1.00
```

```
                                                       INTEREST       0.    0.199    0.000    0.199
                                                       ON LAND

P 9  CHLORINATION      DCL2      TCL2                               CCOST    COSTO    ACOST    TCOST     ECF
                          8.0       30.0               FEED          82081.    0.598    0.175    0.774     1.20
                                                       SYSTEM

                                                       CONTACT       87024.    0.000    0.186    0.186     1.50
                                                       BASIN

     ADMINISTRATIVE                                                 CCOST    COSTO    ACOST    TCOST
     AND LABORATORY                                                 148339.    0.410    0.317    0.728

     GARAGE                                                         CCOST    COSTO    ACOST    TCOST
     AND SHOP                                                        43898.    0.000    0.094    0.094

     LABORATORY        XLAB                                         CCOST    COSTO    ACOST    TCOST
     OPERATION            1.0                                            0.    0.473    0.000    0.473

     YARDWORK                                                       CCOST    COSTO    ACOST    TCOST
     OPERATION                                                           0.    0.257    0.000    0.257
```

```
                              TOTAL PLANT COST

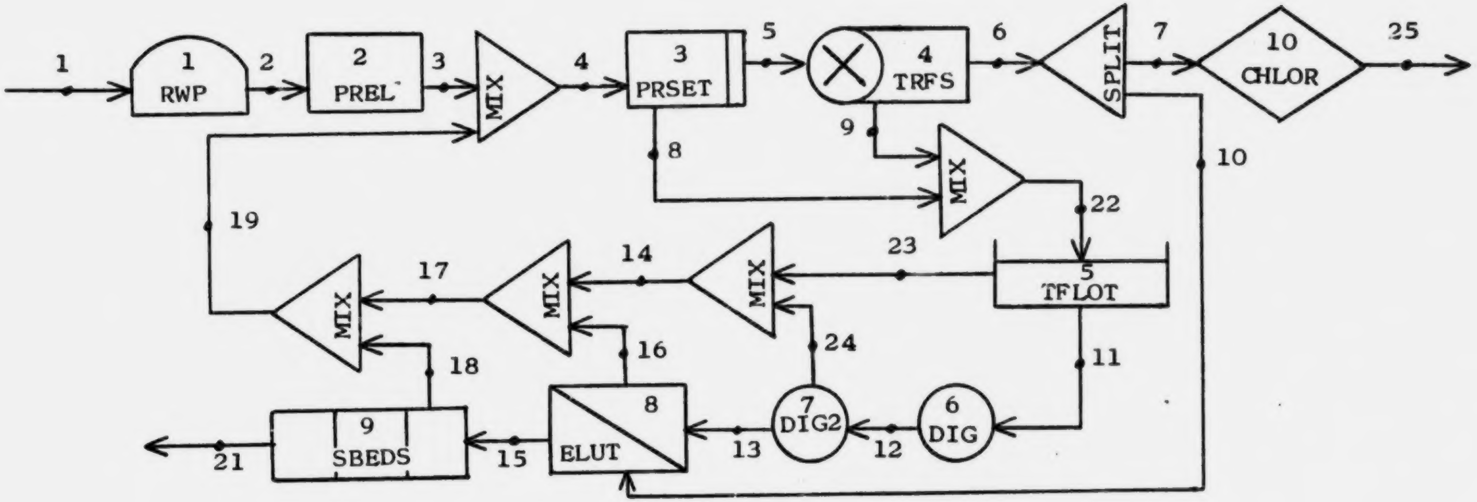
                    TOTAL CAPITAL COST =   4682381. DOLLARS
                TOTAL AMORTIZATION COST =     10.803 CENTS/1000 GAL.
                       TOTAL O + M COST =      9.420 CENTS/1000 GAL.
                  TOTAL TREATMENT COST =     20.223 CENTS/1000 GAL.


   CCI        WPI        RI         YRS        DHR        PCT         QA       CCINT       XLAB       CKWH
   1.506      1.122      0.060      25.0       3.50       0.150      1000.       0.06       1.00       0.015


  RATIO       TCAP       YARD       TCC        XLAND       ENG        SUBT1       FISC       SUBT2      XINT
   1.338    3498230.    489752.   3987973.     30878.    349864.    4368718.     33270.    4401984.   280389.

  ACRE         AF
   23.60     0.07822
```

EXECUTIVE PROGRAM
Standard Test System Diagram Number 3



1
1 RWP
2
2 PREL
3
MIX
4
3 PRSET
5
4 TRFS
6
SPLIT
7
10 CHLOR
25
8
9
MIX
22
10
19
5 TFLOT
23
MIX
14
MIX
17
MIX
24
16
18
11
7 DIG2
6 DIG
8 ELUT
9 SBEDS
21
15
13
12

INPUT DATA

K	N	Process	IS1	IS2	OS1	OS2	III
0	1	15 RWP	1	0	2	0	2
0	2	1 PREL	2	0	3	0	2
1	0	4 MIX	3	19	4	0	1
0	3	2 PRSET	4	0	5	8	0
0	4	11 TRFS	5	0	6	9	0
0	0	4 MIX	8	9	22	0	0
0	0	5 SPLIT	6	0	7	10	0
0	5	13 TFLOT	22	0	11	23	0
0	6	6 DIG	11	0	12	0	0
0	7	21 DIG2	12	0	13	24	0
0	8	9 ELUT	13	10	15	16	0
0	9	10 SBEDS	15	0	21	18	0
0	0	4 MIX	23	24	14	0	0
0	0	4 MIX	16	14	17	0	0
1	0	4 MIX	17	18	19	0	1
0	10	12 CHLOR	7	0	25	0	2
9							

DATA CARD INPUT

```
     10 MGD        EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 3
   1   1                                                .1
       10.      105.       30.       10.        2.       30.      140.      224.
      254.       43.       11.       19.        4.      500.      250.       60.
     1.506     1.122       .06       25.      3.50       .15     1000.       .06
        0.      .015
0  1  15 RWP       1         0         2         0                                       2
       30.
                                                                              1.
0  2   1 PREL      2         0         3         0                                       2
        1.
                                                                              1.
1  0   4 MIX       3        19         4         0                                       1
0  3   2 PRSET     4         0         5         8                                       0
        .5      400.       14.
                                                                    1.       1.2
0  4  11 TRFS      5         0         6         9                                       0
       26.       20.       10.       10.        2.        .6        1.     2000.
       30.                                                 1.5       1.2       1.2
0  0   4 MIX       8         9        22         0                                       0
0  0   5 SPLIT     6         0         7        10                                       0
0  5  13 TFLOT    22         0        11        23                                       0
       .95    40000.     1150.       48.      100.       10.       .45
                                                                              2.
0  6   6 DIG      11         0        12         0                                       0
       15.       30.
                                                                             1.3
0  7  21 DIG2     12         0        13        24                                       0
       .81    50000.       15.
                                                                              1.
0  8   9 ELUT     13        10        15        16                                       0
       .76    60000.        3.      800.        9.
                                                                             1.5
0  9  10 SBEDS    15         0        21        18                                       0
     .0078       .35       50.
                                                                             1.5
0  0   4 MIX      23        24        14         0                                       0
0  0   4 MIX      16        14        17         0                                       0
1  0   4 MIX      17        18        19         0                                       1
0 10  12 CHLOR     7         0        25         0                                       2
        8.       30.
                                                                   1.5       1.2
9
```

```
                              EXECUTIVE
                       DIGITAL COMPUTER PROGRAM
                                 FOR
           PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

                                 BY
                            ROBERT SMITH
                          RICHARD G. EILERS

                  U.S. ENVIRONMENTAL PROTECTION AGENCY
              ADVANCED WASTE TREATMENT RESEARCH LABORATORY
                          CINCINNATI, OHIO


 10 MGD       EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 3

                           SYSTEM DIAGRAM
                             INPUT DATA

K      N     PROCESS        IS1       IS2       OS1       OS2       III

0      1    15  RWP           1         0         2         0         2
0      2     1  PREL          2         0         3         0         2
1      0     4  MIX           3        19         4         0         1
0      3     2  PRSET         4         0         5         8         0
0      4    11  TRFS          5         0         6         9         0
0      0     4  MIX           8         9        22         0         0
0      0     5  SPLIT         6         0         7        10         0
0      5    13  TFLOT        22         0        11        23         0
0      6     6  DIG          11         0        12         0         0
0      7    21  DIG2         12         0        13        24         0
0      8     9  ELUT         13        10        15        16         0
0      9    10  SBEDS        15         0        21        18         0
0      0     4  MIX          23        24        14         0         0
0      0     4  MIX          16        14        17         0         0
1      0     4  MIX          17        18        19         0         1
0     10    12  CHLOR         7         0        25         0         2
9      0     0                0         0         0         0         0
```

```
                              EXECUTIVE
                       DIGITAL COMPUTER PROGRAM
                                 FOR
           PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTEMS

                                  BY
                             ROBERT SMITH
                           RICHARD G. EILERS

                   U.S. ENVIRONMENTAL PROTECTION AGENCY
              ADVANCED WASTE TREATMENT RESEARCH LABORATORY
                          CINCINNATI, OHIO



  10 MGD        EXECUTIVE PROGRAM STANDARD TEST SYSTEM  NUMBER 3

                            SYSTEM DIAGRAM
                              INPUT DATA

  K      N     PROCESS          IS1       IS2       OS1       OS2       III

  0      1    15  RWP            1         0         2         0         2
  0      2     1  PREL           2         0         3         0         2
  1      0     4  MIX            3        19         4         0         1
  0      3     2  PRSET          4         0         5         8         0
  0      4    11  TRFS           5         0         6         9         0
  0      0     4  MIX            8         9        22         0         0
  0      0     5  SPLIT          6         0         7        10         0
  0      5    13  TFLOT         22         0        11        23         0
  0      6     6  DIG           11         0        12         0         0
  0      7    21  DIG2          12         0        13        24         0
  0      8     9  ELUT          13        10        15        16         0
  0      9    10  SBEDS         15         0        21        18         0
  0      0     4  MIX           23        24        14         0         0
  0      0     4  MIX           16        14        17         0         0
  1      0     4  MIX           17        18        19         0         1
  0     10    12  CHLOR          7         0        25         0         2
  9      0     0                 0         0         0         0         0
```

```
                              STREAM CHARACTERISTICS

                                                 VOLUME FLOW, MILLIONS OF GALLONS PER DAY
                                                 CONCENTRATIONS, MILLIGRAMS PER LITER

S 1.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
         10.000     105.000      30.000      10.000       2.000      30.000    140.000     224.000
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        250.000      43.000      11.000      19.000       4.000     500.000     60.000     254.000

S 2.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
         10.000     105.000      30.000      10.000       2.000      30.000    140.000     224.000
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        250.000      43.000      11.000      19.000       4.000     500.000     60.000     254.000

S 3.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
         10.000     105.000      30.000      10.000       2.000      30.000    140.000     224.000
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        250.000      43.000      11.000      19.000       4.000     500.000     60.000     254.000

S 4.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
         14.096      86.943      31.655       8.151       1.630      31.655    103.207     187.330
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        258.149      36.523      10.999      20.902       4.925     499.999     47.841     218.994

S 5.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
         14.079      43.526      15.847       4.080       0.816      15.847     51.668      93.782
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        258.149      36.523      10.999      20.902       4.925     499.999     47.841     109.634

S 6.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
         10.056      14.975       9.508       0.807       0.161       9.508     10.223      20.539
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        258.149      19.436      10.999      19.969       5.472     499.999     15.776      30.209

S 7.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
          9.999      14.975       9.508       0.807       0.161       9.508     10.223      20.539
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        258.149      19.436      10.999      19.969       5.472     499.999     15.776      30.209

S 8.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
          0.017   34777.554   12662.173    3260.564     652.113   12662.173  41283.007   74932.265
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        258.149      36.523      10.999      20.902       4.925     499.999     47.841   87597.672

S 9.        Q          SOC        SNBC        SON         SOP         SFM        SBOD        VSS
          4.022      49.918      31.695       2.691       0.538      31.695     34.077      68.463
          ALK         DOC        DNBC         DN          DP         DFM        DBOD        TSS
        258.149      19.436      10.999      19.969       5.472     499.999     15.776     100.697
```

```
S10.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.056     14.975      9.508      0.807      0.161      9.508     10.223     20.539
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      258.149     19.436     10.999     19.969      5.472    499.999     15.776     30.209

S11.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.046  16701.359   7197.225   1401.625    280.325   7197.225  17746.418  32757.152
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      258.149     19.511     10.999     19.973      5.470    499.999     15.916  40000.007

S12.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.046   7542.333   7197.225    642.800    128.560   7197.225    645.352  17950.750
          ALK        DOC       DNBC         DN         DP        DFM       DBCD        TSS
     2019.001    126.036     10.999    513.209    157.235    499.999    215.117  25147.972

S13.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.018  14995.910  14309.753   1278.037    255.607  14309.753   1283.111  35690.257
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
     2019.001    126.036     10.999    513.209    157.235    499.999    215.117  50000.007

S14.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        4.021     26.608     20.096      2.254      0.450     20.096     12.160     59.092
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      270.157     20.237     10.999     23.337      6.505    499.999     17.275     79.216

S15.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.011  18016.347  17174.800   1533.770    306.754  17174.800   1573.683  42824.617
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      698.362     46.086     10.999    143.279     43.413    499.999     65.612  60000.007

S16.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.063   1078.361   1027.990     91.803     18.360   1027.990     94.192   2563.250
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      698.362     46.086     10.999    143.279     43.413    499.999     65.612   3591.276

S17.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        4.084     42.951     35.758      3.646      0.729     35.758     13.434     98.005
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      276.811     20.639     10.999     25.200      7.078    499.999     18.026    133.791

S18.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        0.011     15.013     14.312      1.278      0.255     14.312      1.311     35.687
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      698.362     46.086     10.999    143.279     43.413    499.999     65.612     50.000

S19.        Q        SOC       SNBC        SON        SOP        SFM       SBOD        VSS
        4.096     42.870     35.696      3.639      0.727     35.696     13.399     97.823
          ALK        DOC       DNBC         DN         DP        DFM       DBOD        TSS
      278.040     20.713     10.999     25.545      7.184    499.999     18.165    133.547
```

```
S21.        Q        SOC       SNBC       SON       SOP       SFM       SBOD       VSS
        0.000      0.000      0.000     0.000     0.000     0.000      0.000     0.000
          ALK        DOC       DNBC        DN        DP       DFM       DBOD       TSS
        0.000      0.000      0.000     0.000     0.000     0.000      0.000     0.000

S22.        Q        SOC       SNBC       SON       SOP       SFM       SBOD       VSS
        4.040    201.378     86.781    16.900     3.380    86.781    213.979   394.972
          ALK        DOC       DNBC        DN        DP       DFM       DBOD       TSS
      258.149     19.511     10.999    19.973     5.470   500.000     15.916   482.303

S23.        Q        SOC       SNBC       SON       SOP       SFM       SBOD       VSS
        3.993     10.185      4.389     0.854     0.170     4.389     10.822    19.977
          ALK        DOC       DNBC        DN        DP       DFM       DBOD       TSS
      258.149     19.511     10.999    19.973     5.470   499.999     15.916    24.394

S24.        Q        SOC       SNBC       SON       SOP       SFM       SBOD       VSS
        0.027   2418.219   2307.570   206.094    41.218  2307.570    206.912  5755.359
          ALK        DOC       DNBC        DN        DP       DFM       DBOD       TSS
     2019.001    126.036     10.999   513.209   157.235   499.999    215.117  8062.930

S25.        Q        SOC       SNBC       SON       SOP       SFM       SBOD       VSS
        9.999     14.975      9.508     0.807     0.161     9.508     10.223    20.539
          ALK        DOC       DNBC        DN        DP       DFM       DBOD       TSS
      258.149     19.436     10.999    19.969     5.472   499.999     15.776    30.209
```

```
                                    PROCESS CHARACTERISTICS

                                              CCOST = CAPITAL COST, DOLLARS
                                              COSTO = OPERATING + MAINTENANCE COST, CENTS/1000 GAL.
                                              ACOST = AMORTIZATION COST, CENTS/1000 GAL.
                                              TCOST = TOTAL TREATMENT COST, CENTS/1000 GAL.

P 1  RAW WASTEWATER    HEAD      QP                                            CCOST     COSTO     ACOST     TCOST      ECF
     PUMPING           30.00   14.80                                           474645.   0.310     1.017     1.327      1.00

P 2  PRELIMINARY      IPREL                                                    CCOST     COSTO     ACOST     TCOST      ELF
     TREATMENT           1.0                                                   144411.   0.412     0.309     0.721      1.00

P 3  PRIMARY           FRPS      URPS      HPWK      GPS       APS       PGPM
     SEDIMENTATION      0.50     400.0     14.0     1375.2    12.300     146.

                                                                               CCOST     COSTO     ACOST     TCOST      ECF
                                                                   SETTLER     230458.   0.218     0.493     0.712      1.20

                                                                   SLUDGE      68014.    0.237     0.145     0.383      1.00
                                                                   PUMPS

P 4  TRICKLING         BOD       DEGC       HQ       SAREA     URSS      XRSS      RECYCL    GSS       HEAD
     FILTER-           26.0      20.00     10.00     10.00     2.00      0.6000    1.0       2000.0    30.0
     FINAL SETTLER
                       AFS       VOL       FAREA     DEPTH
                       8.44      465915.   61328.    6.33

                                                                               CCOST     COSTO     ACOST     TCOST      ECF
                                                                   FILTER      812481.   0.142     1.741     1.883      1.20

                                                                   FINAL       176754.   0.172     0.378     0.551      1.20
                                                                   SETTLER

                                                                   SLUDGE      376630.   0.414     0.807     1.221      1.50
                                                                   PUMPS

P 5  FLOTATION         TRR       TSS       GTH       GSTH      HPWK      DPOLY     CPOLY
     THICKENING        0.95      40000.    1150.00   48.00     100.00    10.00     0.45

                       ATHM      XN        ATHM1                                CCOST     COSTO     ACOST     TCOST
                       1000.0    12.0      11669.3                              2046806.  2.158     4.386     6.545


P 7  SECOND STAGE      TRR       TSS       TD        VDIG                      CCOST     COSTO     ACOST     TCOST      ECF
     ANAEROBIC         0.81      50000.    15.0      92.                       300117.   0.258     0.643     0.901      1.00
```

```
    DIGESTION

P 8 ELUTRIATION        ERR      TSS      WRE      GE       GES      AE
                        0.76   60000.      3.0   800.0       9.0  1308.
                                                                   CCOST    COSTO    ACOST    TCOST      ECF
                                                                   61909.   0.066    0.132    0.199     1.50

P 9 SLUDGE DRYING      SBL      SOUT     TSS      ASB              CCOST    COSTO    ACOST    TCOST      ECF
    BEDS            0.007800    0.35      50.   78676.             118973.  0.539    0.254    0.794     1.50

P10 CHLORINATION      DCL2      TCL2                               CCOST    COSTO    ACOST    TCOST      ECF
                        8.0      30.0                    FEED      81755.   0.599    0.175    0.774     1.20
                                                         SYSTEM

                                                         CONTACT    86687.   0.000    0.185    0.185     1.50
                                                         BASIN

    ADMINISTRATIVE                                                 CCOST    COSTO    ACOST    TCOST
    AND LABORATORY                                                 147710.  0.410    0.316    0.726

    GARAGE                                                         CCOST    COSTO    ACOST    TCOST
    AND SHOP                                                       43712.   0.000    0.093    0.093

    LABORATORY         XLAB                                        CCOST    COSTO    ACOST    TCOST
    OPERATION           0.0                                            0.   0.288    0.000    0.288

    YARDWORK                                                       CCOST    COSTO    ACOST    TCOST
    OPERATION                                                          0.   0.257    0.000    0.257
```

```
                                  TOTAL PLANT COST

                          TOTAL CAPITAL COST =   5523864. DOLLARS
                     TOTAL AMORTIZATION COST =     11.838 CENTS/1000 GAL.
                            TOTAL O + M COST =      6.744 CENTS/1000 GAL.
                        TOTAL TREATMENT COST =     18.583 CENTS/1000 GAL.


  CCI        WPI         RI         YRS        DHR        PCT        DA      CCINT       XLAB       CKWH
  1.506      1.122      0.060       25.0       3.50      0.150      1000.      0.06       0.00      0.015


 RATIO       TCAP       YARD        TCC       XLAND       ENG      SUBT1       FISC      SUBT2       XINT
  1.332   4144470.    580225.   4724684.     19976.    401993.   5146656.     36181.   5182838.    341017.

  ACRE        AF
  19.97   0.07822
```

```
      INTEGER OS1,OS2
      DIMENSION IFAIL(10),LOOP(10),NN(10),NAME(3),LIST(40)
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DEFINE FILE 10 (50,15,U,NNNNN)
      INP=2
      IO=5
      READ(INP,1) NCASE
    1 FORMAT(I2)
      DO 1120 IJ=1,NCASE
      DO 5 I=1,20
      DO 5 J=1,30
      SMATX(I,J)=0.
    5 TMATX(I,J)=0.
      DO 10 I=1,20
      IP(I)=0
      DO 10 J=1,20
      DMATX(I,J)=0.
   10 OMATX(I,J)=0.
      DO 15 I=1,20
      DO 15 J=1,5
      CCOST(I,J)=0.
      COSTO(I,J)=0.
      ACOST(I,J)=0.
   15 TCOST(I,J)=0.
      DO 17 I=1,10
      IFAIL(I)=0
      LOOP(I)=0
   17 NN(I)=0
      IAERF=0
      CLAND=0.
      DLAND=0.
      KKK=1
      READ(INP,18) LIST
   18 FORMAT(40A2)
      READ(INP,20) NIS,(NN(I),I=1,10),EPS
   20 FORMAT(11I4,5X,F10.3)
      DO 40 J=1,NIS
      LL=NN(J)
   40 READ(INP,60) (SMATX(I,LL),I=2,17)
   60 FORMAT(8F10.3/8F10.3)
      READ(INP,60) (DMATX(I,20),I=1,16)
      WPI=DMATX(2,20)
      WPI=WPI/1.122
      DHR=DMATX(5,20)
      PCT=DMATX(6,20)
      WRITE(IO,70)
   70 FORMAT(1H1,//,55X,'EXECUTIVE',/,47X,'DIGITAL COMPUTER PROGRAM',/,
     . 58X,'FOR',/,34X,'PRELIMINARY DESIGN OF WASTEWATER TREATMENT SYSTE
     .MS',//,58X,'BY',/,53X,'ROBERT SMITH',/,51X,'RICHARD G. EILERS',
     . //,41X,'U.S. ENVIRONMENTAL PROTECTION AGENCY',/,37X,'ADVANCED WAS
     .TE TREATMENT RESEARCH LABORATORY',/,50X,
     . 'CINCINNATI, OHIO',/////)
      WRITE(IO,80) LIST
   80 FURMAT(20X,40A2,//,52X,'SYSTEM DIAGRAM',/,54X,
     . 'INPUT DATA',//,24X,'K',5X,'N',5X,'PROCESS',9X,'IS1',7X,
     . 'IS2',7X,'OS1',7X,'OS2',7X,'III',/)
```

```
 100 READ(INP,120) K,N,IPROC,(NAME(I),I=1,3),IS1,IS2,OS1,OS2,III
 120 FORMAT(I1,1X,I2,2X,I2,1X,3A2,4X,I2,8X,I2,8X,I2,8X,I2,28X,I1)
     WRITE(IO,140) K,N,IPROC,(NAME(I),I=1,3),IS1,IS2,OS1,OS2,III
 140 FORMAT(24X,I1,4X,I2,4X,I2,2X,3A2,7X,I2,8X,I2,8X,I2,8X,I2,8X,I2)
     IF(K-9) 160,295,160
 160 SMATX(1,IS1)=IS1
     SMATX(1,OS1)=OS1
     IF(IS2) 180,200,180
 180 SMATX(1,IS2)=IS2
 200 IF(OS2) 220,240,220
 220 SMATX(1,OS2)=OS2
 240 IF(N) 260,295,260
 260 IP(N)=IPROC
     READ(INP,60) (DMATX(I,N),I=1,16)
 295 WRITE(10'KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
     KKK=KKK+1
     IF(K-9) 100,300,100
 300 KKK=1
     K=0
     INDC=0
     IN=1
     ITER=0
 320 ITER=ITER+1
     IF(ITER-25) 330,330,325
 325 WRITE(IO,326)
 326 FORMAT(/////,10X,'EXECUTIVE ITERATION DOES NOT CONVERGE',/,10X,
    . 'PRINTOUT IS FOR THE LAST ITERATION')
 328 READ(10'KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
     KKK=KKK+1
     IF(III-2) 328,540,328
 330 IFLUK=0
 340 IFAIL(IN)=0
     KOUT=0
 360 READ(10'KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
     KKK=KKK+1
     IF(K-9) 380,1110,380
 380 IF(K) 390,420,390
 390 IF(INDC) 420,400,420
 400 INDC=K
 420 IF(K) 440,500,440
 440 IF(K-INDC) 460,500,460
 460 LOOP(IN)=INDC
     IN=IN+1
     INDC=K
     KOUT=0
     IF(IFLUK-1) 480,500,480
 480 IFLUK=IFAIL(IN-1)
 500 IF(K-INDC) 540,520,540
 520 KOUT=KOUT+1
 540 GO TO (550,560,570,590,600,610,620,630,640,650,660,670,680,690,
    . 691,692,693,694,695,696,697,698,699),IPROC
 550 CALL PREL
     GO TO 700
 560 CALL PRSET
     GO TO 700
 570 CALL AERFS
     IF(IAERF) 1120,580,1120
 580 GO TO 700
 590 CALL MIX
     GO TO 700
 600 CALL SPLIT
     GO TO 700
 610 CALL DIG
     GO TO 700
 620 CALL VACF
     GO TO 700
 630 CALL THICK
     GO TO 700
 640 CALL ELUT
     GO TO 700
 650 CALL SBEDS
     GO TO 700
 660 CALL TRFS
     GO TO 700
 670 CALL CHLOR
     GO TO 700
 680 CALL TFLOT
     GO TO 700
 690 CALL MHINC
     GO TO 700
 691 CALL RWP
     GO TO 700
 692 CALL SHT
     GO TO 700
 693 CALL CENT
     GO TO 700
 694 CALL AEROB
     GO TO 700
 695 CALL POSTA
     GO TO 700
 696 CALL EQUAL
     GO TO 700
 697 CALL DIG2
     GO TO 700
 698 CALL LANDD
     GO TO 700
 699 CALL LIME
 700 IF(III-2) 720,340,720
 720 DO 740 I=2,17
     IF(ABS(SMATX(I,OS1)-TMATX(I,OS1))-EPS) 740,740,800
 740 CONTINUE
     IF(OS2) 760,820,760
 760 DO 780 I=2,17
     IF(ABS(SMATX(I,OS2)-TMATX(I,OS2))-EPS) 780,780,800
 780 CONTINUE
     GO TO 820
 800 IFAIL(IN)=1
 820 DO 840 I=1,20
 840 TMATX(I,OS1)=SMATX(I,OS1)
     IF(OS2) 860,900,860
 860 DO 880 I=1,20
 880 TMATX(I,OS2)=SMATX(I,OS2)
 900 IF(KOUT-2) 360,920,360
 920 IF(IFAIL(IN)) 980,940,980
 940 IF(IFLUK) 980,960,980
 960 IF(III-1) 980,1080,980
 980 IF(IFAIL(IN)) 1000,1060,1000
1000 KKK=1
1020 READ(10*KKK) K,N,IPROC,IS1,IS2,OS1,OS2,III
     KKK=KKK+1
     IF(K-INDC) 1020,1040,1020
1040 KKK=KKK-1
     IF(III-1) 340,320,340
1060 INDC=LOOP(IN-1)
     KOUT=1
     IN=IN-1
     GO TO 360
1080 INDC=0
     GO TO 320
1110 CALL COST
     CALL PRINT
1120 CONTINUE
     CALL EXIT
     END
```

PRELIMINARY TREATMENT

```
      SUBROUTINE PREL
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DO 10 I=2,17
   10 SMATX(I,OS1)=SMATX(I,IS1)
      IPREL=DMATX(1,N)
      X=ALOG(SMATX(2,IS1)*DMATX(16,N))
      IF(IPREL) 30,20,30
   20 CCOST(N,1)=EXP(2.566569+.619151*X)*1000.
      GO TO 40
   30 CCOST(N,1)=EXP(3.259716+.619151*X)*1000.
   40 X=ALOG(SMATX(2,IS1))
      OHRS=EXP(6.398716+.230956*X+.164959*X**2.-.014601*X**3.)
      XMHRS=EXP(5.846098+.206513*X+.068842*X**2.+.023824*X**3.-
     . .004410*X**4.)
      TMSU=EXP(7.235657+.399935*X-.224979*X**2.+.110099*X**3.-
     . .011026*X**4.)
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      RETURN
      END
```

PRIMARY SEDIMENTATION

```
      SUBROUTINE PRSET
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      HPWK=DMATX(3,N)
      SMATX(2,OS2)=DMATX(1,N)*SMATX(2,IS1)/DMATX(2,N)
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      TEMP1=(1.-DMATX(1,N))*SMATX(2,IS1)/SMATX(2,OS1)
      TEMP2=DMATX(1,N)*SMATX(2,IS1)/SMATX(2,OS2)
      DO 10 I=3,10
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS2)=SMATX(I,IS1)
   20 SMATX(I,OS1)=SMATX(I,OS2)
      GPS=-2780.*ALOG(DMATX(1,N))-551.7
      APS=SMATX(2,IS1)*1000./GPS*DMATX(16,N)
      X=ALOG(APS)
      CCOST(N,1)=EXP(3.716354+.389861*X+.084560*X**2.-.004718*X**3.)*
     . 1000.
      X=ALOG(APS/DMATX(16,N))
      OHRS=EXP(5.846565+.254813*X+.113703*X**2.-.010942*X**3.)
      XMHRS=EXP(5.273419+.228329*X+.122646*X**2.-.011672*X**3.)
      TMSU=EXP(5.669881+.750799*X)
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      PGPM=SMATX(2,OS2)*116666.7/HPWK*DMATX(15,N)
      X=ALOG(PGPM)
      CCOST(N,2)=EXP(2.237330+.207628*X+.026479*X**2.)*1000.
      X=ALOG(PGPM/DMATX(15,N))
      OHRS=EXP(4.945155+.419391*X)
      XMHRS=EXP(3.993365+.444966*X)
      TMSU=EXP(4.433129+.642272*X)
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=GPS
      OMATX(2,N)=APS
      OMATX(3,N)=PGPM
      RETURN
      END
      SUBROUTINE AERFS
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      HEAD=DMATX(9,N)
      BOD2=SMATX(8,IS1)+SMATX(17,IS1)
      DBOD2=SMATX(17,IS1)
      CEDR=.18*1.047**(DMATX(3,N)-28.)
      CAER=DMATX(4,N)*1.047**(DMATX(3,N)-20.)
      SA=DMATX(2,N)/1000.
      TA=(BOD2-DMATX(1,N))/(DMATX(1,N)*CAER*SA*24.)
      VAER=SMATX(2,IS1)*TA
      XRSS=556.1*DMATX(8,N)**.4942/DMATX(2,N)**1.8165/(TA*24.)**.4386
      ALD=DMATX(10,N)*.87*SMATX(14,IS1)
      IF(ALD) 5,6,5
    5 PALS=1.305*SMATX(14,IS1)+3.*ALD
      GO TO 7
    6 PALS=0.
    7 ASMAX=DMATX(1,N)/XRSS/.685
      ASMIN=0.
      IF(ASMAX-DMATX(2,N)) 20,20,10
   10 ASMAX=DMATX(2,N)
   20 XMLAS=(ASMAX+ASMIN)/2.
      FOOD=SMATX(8,IS1)+DBOD2
      FMAX=FOOD
      N1=1
      GO TO 80
   30 ERROR=FMAX-FMIN
      IF(ERROR-.1) 220,220,40
   40 FOOD=(FMAX+FMIN)/2.
   50 IF(FOOD-SMATX(17,IS1)) 60,60,70
   60 DBOD4=SMATX(17,IS1)-FOOD
      SBOD4=SMATX(8,IS1)
      GO TO 80
   70 SBOD4=(SMATX(8,IS1)+SMATX(17,IS1)-FOOD)*.7
      DBOD4=.233*SBOD4
   80 TEMP1=.50*FOOD/XMLAS-XRSS
      SMATX(2,OS2)=(SMATX(2,IS1)*TEMP1-CEDR*VAER)/(DMATX(7,N)-XRSS)
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      N1=N1+1
      IF(N1-2) 100,100,90
   90 TEMP2=XRSS*SMATX(2,OS1)+DMATX(7,N)*SMATX(2,OS2)
      XMLBS=SMATX(2,IS1)*SBOD4/TEMP2/.8
      SMATX(8,OS1)=(XMLAS*.685+XMLBS*.8)*XRSS
      SMATX(17,OS1)=DBOD4
      TBOD5=SMATX(8,OS1)+SMATX(17,OS1)
      GO TO 110
  100 TBOD5=XMLAS*XRSS*.685
  110 IF(TBOD5-DMATX(1,N)) 120,120,170
  120 IF(N1-3) 130,140,160
  130 FMIN=(CEDR*VAER/SMATX(2,IS1)+XRSS)*XMLAS/.50
      FOOD=FMIN
      GO TO 50
  140 WRITE(IO,150)
  150 FORMAT(10X,'DEMAND MLASS CANNOT BE HELD')
      IAERF=1
      GO TO 370
```

```
160 FMAX=FOOD
    GO TO 30
170 IF(N1-3) 180,210,200
180 WRITE(IO,190)
190 FORMAT(10X,'BOD5 DEMAND CANNOT BE ACHIEVED')
    IAERF=1
    GO TO 370
200 FMIN=FOOD
210 GO TO 30
220 XMLNB=SMATX(4,IS1)*SMATX(2,IS1)*2.13/TEMP2
    XMLIS=SMATX(2,IS1)*(SMATX(7,IS1)+PALS)/TEMP2
    XMLDS=.12*SMATX(2,IS1)*FOOD/TEMP2-.185*XMLAS
    TEMP3=XMLAS+XMLBS+XMLNB+XMLDS+XMLIS
    TEMP4=TEMP3-DMATX(2,N)
    IF(ABS(TEMP4)-5.) 260,260,230
230 IF(TEMP4) 240,240,250
240 ASMIN=XMLAS
    GO TO 20
250 ASMAX=XMLAS
    GO TO 20
260 SMATX(3,OS1)=(XMLDS+XMLAS)*XRSS/2.46+(XMLBS+XMLNB)*XRSS/2.33
    SMATX(4,OS1)=XMLNB*XRSS/2.33+(XMLDS+.185*XMLAS)*XRSS/2.46
    TEMP5=XRSS*XMLAS/2.46
    SMATX(5,OS1)=.234*TEMP5+(SMATX(3,OS1)-TEMP5)/10.
    SMATX(6,OS1)=SMATX(3,OS1)*.01
    SMATX(7,OS1)=XMLIS*XRSS
    SMATX(9,OS1)=SMATX(3,OS1)*2.38
    SMATX(10,OS1)=SMATX(7,OS1)+SMATX(9,OS1)
    DO 270 I=3,10
270 SMATX(I,OS2)=SMATX(I,OS1)*DMATX(7,N)/XRSS
    SMATX(11,OS1)=SMATX(12,IS1)+DBOD4/1.87
    SMATX(12,OS1)=SMATX(12,IS1)
    SMATX(13,OS1)=(SMATX(2,IS1)*(SMATX(5,IS1)+SMATX(13,IS1))-
   . (SMATX(5,OS1)*SMATX(2,OS1)+SMATX(5,OS2)*SMATX(2,OS2)))/
   . (SMATX(2,OS1)+SMATX(2,OS2))
    SMATX(14,OS1)=(SMATX(2,IS1)*(SMATX(6,IS1)+SMATX(14,IS1))-
   . (SMATX(6,OS1)*SMATX(2,OS1)+SMATX(6,OS2)*SMATX(2,OS2)))/
   . (SMATX(2,OS1)+SMATX(2,OS2))
    SMATX(15,OS1)=SMATX(15,IS1)
    DO 280 I=11,15
280 SMATX(I,OS2)=SMATX(I,OS1)
    QR=(SMATX(2,IS1)*(1.-.50*FOOD/XMLAS)+CEDR*VAER)/(DMATX(7,N)-1.)
    RTURN=QR/SMATX(2,IS1)
    X4X3=(1.+RTURN)/RTURN/DMATX(7,N)
    DN3=SMATX(13,IS1)/(1.+RTURN)
    X3Y=DN3*.99/(X4X3-1.)
    CNIT=.18*EXP(.116*(DMATX(3,N)-15.))
    IF(X4X3) 290,290,300
290 TTAN=0.
    GO TO 310
300 TTAN=(1.+RTURN)*(ALOG(X4X3)+4.605/(DN3+X3Y))/CNIT
310 VNIT=SMATX(2,IS1)*TTAN
    IF(VNIT-VAER) 320,320,330
320 SMATX(16,OS1)=SMATX(16,IS1)+3.57*(SMATX(13,OS1)-SMATX(13,IS1))
    GO TO 340
330 SMATX(16,OS1)=SMATX(16,IS1)
340 SMATX(16,OS2)=SMATX(16,OS1)
    SMATX(17,OS2)=SMATX(17,OS1)
```

```
      DOSAT=(14.16-.3943*DMATX(3,N)+.007714*DMATX(3,N)**2-.0000646*
     . DMATX(3,N)**3)*1.221
      AEFF=DMATX(6,N)*(DOSAT-DMATX(5,N))*1.02**(DMATX(3,N)-20.)/DOSAT
      WFOOD=SMATX(2,IS1)*FOOD*8.33
      WAS=XMLAS*VAER*8.33
      ARCFD=(.577*WFOOD+1.16*CEDR*WAS)/AEFF/.232/.075
      WDN=(SMATX(2,OS1)*SMATX(13,OS1)+SMATX(2,OS2)*SMATX(13,OS2))*8.33
      IF(VNIT-VAER) 350,350,360
  350 ARCFD=ARCFD+4.6*WDN/AEFF/.232/.075
  360 BSIZE=DMATX(15,N)*ARCFD/1440.
      CFPGL=ARCFD/1000000./SMATX(2,IS1)
      VAER=VAER*DMATX(16,N)
      QR=QR*DMATX(14,N)
      AFS=SMATX(2,OS1)*1000./DMATX(8,N)*DMATX(13,N)
      X=ALOG(VAER*1000./7.48)
      CCOST(N,1)=EXP(2.414380+.175682*X+.084742*X**2.-.002670*X**3.)*
     . 1000.
      OHRS=0.
      XMHRS=0.
      TMSU=0.
      COSTO(N,1)=0.
      X=ALOG(BSIZE/1000.)
      CCOST(N,2)=EXP(4.145454+.633339*X+.031939*X**2.-.002419*X**3.)*
     . 1000.
      X=ALOG(BSIZE/1000./DMATX(15,N))
      OHRS=EXP(6.900586+.323725*X+.059093*X**2.-.004926*X**3.)
      XMHRS=EXP(6.169937+.294853*X+.175999*X**2.-.040947*X**3.+
     . .003300*X**4.)
      HP=BSIZE/DMATX(15,N)*8.1*144./(33000.*.8)
      XKW=.8*HP
      XKWPY=XKW*24.*365.
      ECOST=XKWPY*DMATX(10,20)
      SCOST=EXP(.621382+.482047*X)*1000.
      TMSU=ECOST+SCOST
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      X=ALOG(QR)
      CCOST(N,3)=EXP(3.481553+.377485*X+.093349*X**2.-.006222*X**3.)*
     . 1000.
      X=ALOG(QR/DMATX(14,N))
      OHRS=EXP(6.097269+.253066*X-.193659*X**2.+.078201*X**3.-
     . .006680*X**4.)
      XMHRS=EXP(5.911541-.013158*X+.076643*X**2.)
      E12=EXP(6.799199+.785690*X-.087865*X**2.+.042646*X**3.-
     . .004488*X**4.)*(HEAD/30.)
      S12=EXP(5.851743+.301610*X+.197183*X**2.-.017962*X**3.)
      TMSU=E12+S12
      COSTO(N,3)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      X=ALOG(AFS)
      CCOST(N,4)=EXP(3.716354+.389861*X+.084560*X**2.-.004718*X**3.)*
     . 1000.
      X=ALOG(AFS/DMATX(13,N))
      OHRS=EXP(5.846565+.254813*X+.113703*X**2.-.010942*X**3.)
      XMHRS=EXP(5.273419+.228329*X+.122646*X**2.-.011672*X**3.)
      TMSU=EXP(5.669881+.750799*X)
      COSTO(N,4)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=BOD2
      OMATX(2,N)=DOSAT
      OMATX(3,N)=XRSS
      OMATX(4,N)=AFS
      OMATX(5,N)=CAER
      OMATX(6,N)=CEDR
      OMATX(7,N)=VAER
      OMATX(8,N)=VNIT
      OMATX(9,N)=XMLAS
      OMATX(10,N)=XMLBS
      OMATX(11,N)=XMLNB
      OMATX(12,N)=XMLDS
      OMATX(13,N)=XMLIS
      OMATX(14,N)=FOOD
      OMATX(15,N)=RTURN
      OMATX(16,N)=CNIT
      OMATX(17,N)=ARCFD
      OMATX(18,N)=BSIZE
      OMATX(19,N)=CFPGL
      OMATX(20,N)=QR
  370 RETURN
      END
```

STREAM MIXER

```
      SUBROUTINE MIX
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      SMATX(2,OS1)=SMATX(2,IS1)+SMATX(2,IS2)
      IF(SMATX(2,OS1)) 10,30,10
   10 TEMP1=SMATX(2,IS1)/(SMATX(2,IS1)+SMATX(2,IS2))
      TEMP2=SMATX(2,IS2)/(SMATX(2,IS1)+SMATX(2,IS2))
      DO 20 I=3,17
   20 SMATX(I,OS1)=TEMP1*SMATX(I,IS1)+TEMP2*SMATX(I,IS2)
   30 RETURN
      END
      SUBROUTINE SPLIT
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      DO 10 I=3,17
      SMATX(I,OS1)=SMATX(I,IS1)
   10 SMATX(I,OS2)=SMATX(I,IS1)
      RETURN
      END
      SUBROUTINE DIG
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      IF(DMATX(1,N)-10.) 10,10,20
   10 DMATX(1,N)=10.
   20 C1DIG=.28/EXP(.036*(35.-DMATX(2,N)))
      C2DIG=700.*EXP(.10*(35.-DMATX(2,N)))
      DIG13=C2DIG/(C1DIG*DMATX(1,N)-1.)
      DIG12=SMATX(3,IS1)-SMATX(4,IS1)+SMATX(11,IS1)-SMATX(12,IS1)
      TEMP1=(DIG12-DIG13)/(SMATX(3,IS1)+SMATX(11,IS1))
      SMATX(2,OS1)=SMATX(2,IS1)
      SMATX(3,OS1)=SMATX(4,IS1)+.75*DIG13
      SMATX(4,OS1)=SMATX(4,IS1)
      SMATX(5,OS1)=(1.-TEMP1)*SMATX(5,IS1)
      SMATX(6,OS1)=(1.-TEMP1)*SMATX(6,IS1)
      SMATX(7,OS1)=SMATX(7,IS1)
      SMATX(8,OS1)=(SMATX(3,OS1)-SMATX(4,OS1))*1.87
      SMATX(9,OS1)=SMATX(3,OS1)*2.38
      SMATX(10,OS1)=SMATX(9,OS1)+SMATX(7,OS1)
      SMATX(11,OS1)=SMATX(12,IS1)+.25*DIG13
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(13,OS1)=SMATX(13,IS1)+SMATX(5,IS1)*.65*TEMP1
      SMATX(14,OS1)=SMATX(14,IS1)+TEMP1*SMATX(6,IS1)
      SMATX(15,OS1)=SMATX(15,IS1)
      SMATX(16,OS1)=SMATX(16,IS1)+(SMATX(13,OS1)-SMATX(13,IS1))*3.57
      SMATX(17,OS1)=(SMATX(11,OS1)-SMATX(12,OS1))*1.87
      CH4=163.85*(DIG12-DIG13)*SMATX(2,IS1)
      CO2=249.9*(DIG12-DIG13)*SMATX(2,IS1)-CH4
      VDIG=SMATX(2,IS1)*DMATX(1,N)*1000./7.48*DMATX(16,N)
      X=ALOG(VDIG)
      IF(VDIG-20.) 22,25,25
   22 CCOST(N,1)=EXP(4.594215+.127244*X-.004001*X**2.)*1000.
      GO TO 28
   25 CCOST(N,1)=EXP(7.679634-1.949689*X+.402610*X**2.-.018211*X**3.)*
     . 1000.
   28 X=ALOG(VDIG/DMATX(16,N))
      IF(VDIG-20.) 30,40,40
   30 OHRS=EXP(6.163803+.166305*X-.012470*X**2.)
      XMHRS=EXP(5.726981+.113674*X)
      TMSU=EXP(6.531623+.198417*X+.021660*X**2.)
      GO TO 50
   40 OHRS=EXP(9.129250-1.816736*X+.373282*X**2.-.017290*X**3.)
      XMHRS=EXP(8.566752-1.768137*X+.363173*X**2.-.016620*X**3.)
      TMSU=EXP(8.702803-1.182711*X+.282691*X**2.-.013672*X**3.)
   50 COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=C1DIG
      OMATX(2,N)=C2DIG
      OMATX(3,N)=VDIG
      OMATX(4,N)=CH4
      OMATX(5,N)=CO2
      RETURN
      END
```

VACUUM FILTRATION

```
      SUBROUTINE VACF
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      FE=DMATX(5,N)
      CAO=DMATX(6,N)
      CFE=DMATX(7,N)
      CCAO=DMATX(8,N)
      SMATX(7,IS1)=SMATX(7,IS1)+(FE+CAO)*SMATX(10,IS1)/2000.
      SMATX(10,IS1)=SMATX(10,IS1)+(FE+CAO)*SMATX(10,IS1)/2000.
      SMATX(10,OS2)=DMATX(3,N)
      WP=88./(SMATX(10,IS1)/10000.)**.123
      TEMP1=1000000.*(100.-WP)/WP
      SMATX(2,OS2)=SMATX(2,IS1)*(TEMP1-SMATX(10,IS1))/(TEMP1-
     . SMATX(10,OS2))
      SMATX(2,OS1)=SMATX(2,IS1)-SMATX(2,OS2)
      SMATX(10,OS1)=(SMATX(2,IS1)*SMATX(10,IS1)-SMATX(2,OS2)*
     . SMATX(10,OS2))/SMATX(2,OS1)
      TEMP2=SMATX(10,OS1)/SMATX(10,IS1)
      TEMP3=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP2*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP3*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS1)=TEMP2*SMATX(I,IS1)
   20 SMATX(I,OS2)=SMATX(I,IS1)
      SF=SMATX(10,IS1)/10000.
      SC=WP
      FVF=DMATX(1,N)/11.99/(1./SF-1./SC)
      AVF=SMATX(10,IS1)*SMATX(2,IS1)*58.31/FVF/DMATX(2,N)*DMATX(16,N)
      IVACF=DMATX(4,N)
      PSDD=SMATX(10,IS1)*SMATX(2,IS1)*8.33
      X=ALOG(AVF)
      CCOST(N,1)=EXP(3.288028+.194537*X+.038313*X**2.)*1000.
      X=ALOG(PSDD*365./2000.)
      IF(IVACF) 40,30,40
   30 OHRS=EXP(6.069419-.009894*X+.042699*X**2.)
      GO TO 50
   40 OHRS=EXP(3.714368+.850848*X-.074615*X**2.+.005085*X**3.)
   50 XMHRS=EXP(4.306110-.093695*X+.047738*X**2.)
      SUPP=EXP(-3.113515+.718466*X)*1000.
      CHEM=PSDD*365./2000.*(FE*CFE+CAO*CCAO)
      TMSU=SUPP+CHEM
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=WP
      OMATX(2,N)=AVF
      OMATX(3,N)=PSDD
      RETURN
      END
```

GRAVITY THICKENING

```
      SUBROUTINE THICK
      INTEGER OS1,OS2
      DIMENSION SMAT(20)
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DO 2 I=1,20
    2 SMAT(I)=0.
      IF(IS2) 4,7,4
    4 DO 6 I=1,20
    6 SMAT(I)=SMATX(I,IS2)
    7 SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,OS1)=DMATX(1,N)*(SMATX(2,IS1)*SMATX(10,IS1)+SMAT(2)*
     . SMAT(10))/SMATX(10,OS1)
      TEMP=DMATX(4,N)/DMATX(3,N)*1000000./8.33
      IF(IS2) 9,8,9
    8 WRT=0.
      GO TO 10
    9 WRT=(SMATX(10,IS1)-TEMP)/(TEMP-SMAT(10))
      SMATX(2,IS2)=WRT*SMATX(2,IS1)
      SMAT(2)=SMATX(2,IS2)
   10 SMATX(2,OS2)=SMATX(2,IS1)+SMAT(2)-SMATX(2,OS1)
      TEMP=SMATX(2,IS1)*SMATX(10,IS1)+SMAT(2)*SMAT(10)
      SMATX(10,OS2)=(TEMP-SMATX(2,OS1)*SMATX(10,OS1))/SMATX(2,OS2)
      TEMP=TEMP/(SMATX(2,IS1)+SMAT(2))
      TEMP1=SMATX(10,OS1)/TEMP
      TEMP2=SMATX(10,OS2)/TEMP
      DO 15 I=3,9
      TEMP3=(SMATX(2,IS1)*SMATX(I,IS1)+SMAT(2)*SMAT(I))/
     . (SMATX(2,IS1)+SMAT(2))
      SMATX(I,OS1)=TEMP1*TEMP3
   15 SMATX(I,OS2)=TEMP2*TEMP3
      DO 20 I=11,17
      SMATX(I,OS1)=(SMATX(I,IS1)*SMATX(2,IS1)+SMAT(I)*SMAT(2))/
     . (SMATX(2,IS1)+SMAT(2))
   20 SMATX(I,OS2)=SMATX(I,OS1)
      ATHM=(SMATX(2,OS2)+SMATX(2,OS1))*1000000./DMATX(3,N)*DMATX(16,N)
      X=ALOG(ATHM/1000.)
      CCOST(N,1)=EXP(3.725902+.397690*X+.075742*X**2.-.001977*X**3.-
     . .000296*X**4.)*1000.
      X=ALOG(ATHM/1000./DMATX(16,N))
      IF(EXP(X)-1.) 60,70,70
   60 OHRS=350.
      XMHRS=190.
      TMSU=250.
      GO TO 80
   70 OHRS=EXP(5.846565+.254813*X+.113703*X**2.-.010942*X**3.)
      XMHRS=EXP(5.273419+.228329*X+.122646*X**2.-.011672*X**3.)
      TMSU=EXP(5.669881+.750799*X)
   80 COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=ATHM
      OMATX(2,N)=WRT
      RETURN
      END
```

ELUTRIATION

```
      SUBROUTINE ELUT
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,IS2)=DMATX(3,N)*SMATX(2,IS1)
      AE1=SMATX(2,IS1)*1000000./DMATX(4,N)
      AE2=SMATX(2,IS1)*SMATX(10,IS1)*8.33/DMATX(5,N)
      IF(AE1-AE2) 20,20,10
   10 AE=AE1*DMATX(16,N)
      GO TO 30
   20 AE=AE2*DMATX(16,N)
   30 SMATX(2,OS1)=DMATX(1,N)*SMATX(2,IS1)*SMATX(10,IS1)/SMATX(10,OS1)
      SMATX(2,OS2)=SMATX(2,IS1)+SMATX(2,IS2)-SMATX(2,OS1)
      TEMP=SMATX(2,IS1)*SMATX(10,IS1)+SMATX(2,IS2)*SMATX(10,IS2)
      SMATX(10,OS2)=(TEMP-SMATX(2,OS1)*SMATX(10,OS1))/SMATX(2,OS2)
      TEMP=TEMP/(SMATX(2,IS1)+SMATX(2,IS2))
      TEMP1=SMATX(10,OS1)/TEMP
      TEMP2=SMATX(10,OS2)/TEMP
      DO 40 I=3,9
      TEMP3=(SMATX(2,IS1)*SMATX(I,IS1)+SMATX(2,IS2)*SMATX(I,IS2))/
     . (SMATX(2,IS1)+SMATX(2,IS2))
      SMATX(I,OS1)=TEMP1*TEMP3
   40 SMATX(I,OS2)=TEMP2*TEMP3
      DO 50 I=11,17
      SMATX(I,OS1)=(SMATX(I,IS1)*SMATX(2,IS1)+SMATX(I,IS2)*SMATX(2,IS2))
     . /(SMATX(2,IS1)+SMATX(2,IS2))
   50 SMATX(I,OS2)=SMATX(I,OS1)
      X=ALOG(AE/1000.)
      CCOST(N,1)=EXP(3.725902+.397690*X+.075742*X**2.-.001977*X**3.-
     . .000296*X**4.)*1000.
      X=ALOG(AE/1000./DMATX(16,N))
      IF(EXP(X)-1.) 60,70,70
   60 OHRS=350.
      XMHRS=190.
      TMSU=250.
      GO TO 80
   70 OHRS=EXP(5.846565+.254813*X+.113703*X**2.-.010942*X**3.)
      XMHRS=EXP(5.273419+.228329*X+.122646*X**2.-.011672*X**3.)
      TMSU=EXP(5.669881+.750799*X)
   80 COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=AE
      RETURN
      END
```

SLUDGE DRYING BEDS

```
      SUBROUTINE SBEDS
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      SMATX(2,OS2)=SMATX(2,IS1)
      SMATX(10,OS2)=DMATX(3,N)
      TEMP=SMATX(10,OS2)/SMATX(10,IS1)
      DO 10 I=3,9
   10 SMATX(I,OS2)=TEMP*SMATX(I,IS1)
      DO 20 I=11,17
   20 SMATX(I,OS2)=SMATX(I,IS1)
      SF=SMATX(10,IS1)/10000.
      SC=DMATX(2,N)*100.
      FI=100./6004.8/DMATX(1,N)*(1./SF-1./SC)-.00189
      FSB=1./FI
      TEMP=SMATX(2,IS1)*SMATX(10,IS1)*249.9
      ASB=TEMP/FSB*DMATX(16,N)
      PSDD=SMATX(10,IS1)*SMATX(2,IS1)*8.33
      X=ALOG(ASB/1000.)
      CCOST(N,1)=EXP(1.971125+.083841*X+.146751*X**2.-.007718*X**3.)*
     . 1000.
      X=ALOG(PSDD*365./2000.)
      OHRS=EXP(6.345052-.476780*X+.101319*X**2.)
      XMHRS=EXP(4.290089-.098293*X+.075453*X**2.)
      TMSU=EXP(.693148+1.000000*X)
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=ASB
      RETURN
      END
      SUBROUTINE TRFS
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      HEAD=DMATX(9,N)
      BODIN=SMATX(8,IS1)+SMATX(17,IS1)
      BETA=.0245*1.035**(DMATX(2,N)-20.)
      XN=.91-6.45/DMATX(4,N)
      FAREA=SMATX(2,IS1)/DMATX(3,N)*43560.
      Q6=DMATX(7,N)*SMATX(2,IS1)
      RHQ=((DMATX(7,N)+1.)*DMATX(3,N))**XN
      BOD=(SMATX(17,IS1)+DMATX(6,N)*SMATX(8,IS1))/DMATX(1,N)
      DEPTH=RHQ*ALOG((BOD+DMATX(7,N))/(DMATX(7,N)+1.))/(BETA*DMATX(4,N))
      XPO=EXP(BETA*DMATX(4,N)*DEPTH/RHQ)
      BODO=BODIN/(XPO*(DMATX(7,N)*(1.-1./XPO)+1.))
      DBODO=SMATX(17,IS1)/(XPO*(DMATX(7,N)*(1.-1./XPO)+1.))
      SBOD4=BODO-DBODO
      SBOD5=SBOD4*DMATX(6,N)
      BETAN=.00307*1.141**(DMATX(2,N)-20.)
      XPON=EXP(BETAN*DMATX(4,N)*DEPTH/RHQ)
      SON4=SMATX(5,IS1)*SBOD4/SMATX(8,IS1)
      DN4=(SMATX(13,IS1)+SMATX(5,IS1)-SON4)/(XPON+(XPON-1.)*DMATX(7,N))
      DN5=DN4
      SON5=SON4*DMATX(6,N)
      SMATX(2,OS1)=SMATX(2,IS1)*(1.-DMATX(5,N))/(DMATX(6,N)-DMATX(5,N))
      SMATX(2,OS2)=SMATX(2,IS1)*(1.-DMATX(6,N))/(DMATX(5,N)-DMATX(6,N))
      SMATX(4,OS1)=SMATX(4,IS1)*DMATX(6,N)
      SMATX(4,OS2)=SMATX(4,IS1)*DMATX(5,N)
      SMATX(5,OS1)=SON5
      SMATX(5,OS2)=SON4*DMATX(5,N)
      SMATX(6,OS1)=SMATX(6,IS1)*DMATX(6,N)*SBOD4/SMATX(8,IS1)
      SMATX(6,OS2)=SMATX(6,IS1)*DMATX(5,N)*SBOD4/SMATX(8,IS1)
      SMATX(7,OS1)=SMATX(7,IS1)*DMATX(6,N)
      SMATX(7,OS2)=SMATX(7,IS1)*DMATX(5,N)
      SMATX(8,OS1)=SBOD4*DMATX(6,N)
      SMATX(8,OS2)=SBOD4*DMATX(5,N)
      SMATX(9,OS1)=SBOD4*DMATX(6,N)+SON5+SMATX(4,IS1)*DMATX(6,N)
      SMATX(9,OS2)=SBOD4*DMATX(5,N)+SON4*DMATX(5,N)+SMATX(4,IS1)*
     . DMATX(5,N)
      SMATX(10,OS1)=SMATX(9,OS1)+SMATX(7,OS1)+SMATX(6,OS1)
      SMATX(10,OS2)=SMATX(9,OS2)+SMATX(7,OS2)+SMATX(6,OS2)
      SMATX(12,OS1)=SMATX(12,IS1)
      SMATX(12,OS2)=SMATX(12,IS1)
      SMATX(13,OS1)=DN5
      SMATX(13,OS2)=DN5
      SMATX(14,OS1)=SMATX(14,IS1)+SMATX(6,IS1)*(1.-SBOD4/SMATX(8,IS1))
      SMATX(14,OS2)=SMATX(14,OS1)
      SMATX(15,OS1)=SMATX(15,IS1)
      SMATX(15,OS2)=SMATX(15,IS1)
      SMATX(16,OS1)=SMATX(16,IS1)
      SMATX(16,OS2)=SMATX(16,IS1)
      SMATX(17,OS1)=DBODO
      SMATX(17,OS2)=SMATX(17,OS1)
      SMATX(3,OS1)=(SBOD5+1.87*SMATX(4,OS1))/1.87
      SMATX(3,OS2)=(SMATX(8,OS2)+1.87*SMATX(4,OS2))/1.87
      SMATX(11,OS1)=(DBODO+1.87*SMATX(12,OS1))/1.87
      SMATX(11,OS2)=SMATX(11,OS1)
      PCR=(BODIN-DMATX(1,N))*100./BODIN
      AFS=SMATX(2,IS1)*1000./DMATX(8,N)*DMATX(15,N)
      VOL=FAREA*DEPTH*DMATX(16,N)
      X=ALOG(VOL/1000.)
      CCOST(N,1)=EXP(2.924951+.036285*X+.114673*X**2.-.004587*X**3.)*
     * 1000.
      X=ALOG(SMATX(2,IS1)/DMATX(3,N)*43560./1000.)
      OHRS=EXP(4.536510-.095731*X+.173718*X**2.-.010114*X**3.)
      XMHRS=EXP(4.312739-.052122*X+.157473*X**2.-.010245*X**3.)
      TMSU=EXP(5.105946+.465100*X)
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      X=ALOG(AFS)
      CCOST(N,2)=EXP(3.716354+.389861*X+.084560*X**2.-.004718*X**3.)*
     * 1000.
      X=ALOG(AFS/DMATX(15,N))
      OHRS=EXP(5.846565+.254813*X+.113703*X**2.-.010942*X**3.)
      XMHRS=EXP(5.273419+.228329*X+.122646*X**2.-.011672*X**3.)
      TMSU=EXP(5.669881+.750799*X)
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      X=ALOG(SMATX(2,IS1)*1.5*DMATX(14,N))
      CCOST(N,3)=EXP(3.481553+.377485*X+.093349*X**2.-.006222*X**3.)*
     * 1000.
      X=ALOG(SMATX(2,IS1)*1.5)
      OHRS=EXP(6.097269+.253066*X-.193659*X**2.+.078201*X**3.-
     * .006680*X**4.)
      XMHRS=EXP(5.911541-.013158*X+.076643*X**2.)
      X=ALOG(SMATX(2,IS1))
      E12=EXP(6.779199+.785690*X-.087865*X**2.+.042646*X**3.-
     * .004488*X**4.)*(HEAD/30.)
      S12=EXP(5.851743+.301610*X+.197183*X**2.-.017962*X**3.)
      TMSU=E12+S12
      COSTO(N,3)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=AFS
      OMATX(2,N)=VOL
      OMATX(3,N)=FAREA
      OMATX(4,N)=DEPTH
      RETURN
      END
```

CHLORINATION

```
      SUBROUTINE CHLOR
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      X=ALOG(SMATX(2,IS1)*DMATX(1,N)*8.33*DMATX(16,N))
      CCOST(N,1)=EXP(2.264294-.044271*X+.065029*X**2.-.002536*X**3.)*
     . 1000.
      X=ALOG(SMATX(2,IS1)*DMATX(1,N)*8.33*365./2000.)
      OHRS=EXP(4.538517+.543669*X)
      XMHRS=EXP(3.752071-.224812*X+.158849*X**2.-.006064*X**3.)
      TMSU=EXP(6.620760+.468834*X+.043642*X**2.-.002016*X**3.)
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      X=ALOG(SMATX(2,IS1)*DMATX(2,N)/1.44/7.48*DMATX(15,N))
      CCOST(N,2)=EXP(2.048061+.521909*X-.002674*X**2.+.004159*X**3.)*
     . 1000.
      OHRS=0.
      XMHRS=0.
      TMSU=0.
      COSTO(N,2)=0.
      DO 10 I=2,20
   10 SMATX(I,OS1)=SMATX(I,IS1)
      RETURN
      END
```

FLOTATION THICKENING

```
      SUBROUTINE TFLOT
      INTEGER OS1,CS2
      DIMENSION Y(12),SMAT(20)
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DATA Y/25.,50.,100.,150.,200.,250.,300.,400.,500.,600.,800.,1000./
      DO 5 I=1,20
    5 SMAT(I)=0.
      IF(IS2) 10,20,10
   10 DO 15 I=1,20
   15 SMAT(I)=SMATX(I,IS2)
   20 SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,OS1)=DMATX(1,N)*(SMATX(2,IS1)*SMATX(10,IS1)+
     . SMAT(2)*SMAT(10))/SMATX(10,OS1)
      ATH1=(SMATX(2,IS1)*SMATX(10,IS1)+SMAT(2)*SMAT(10))*
     . 8.33/DMATX(4,N)*168./DMATX(5,N)
      IF(IS2) 30,25,30
   25 ARCY=0.
      GO TO 35
   30 ARCY=.00288*ATH1
      SMATX(2,IS2)=ARCY
   35 SMAT(2)=ARCY
      SMATX(2,OS2)=SMATX(2,IS1)+SMAT(2)-SMATX(2,OS1)
      ATH2=SMATX(2,OS2)*1000000./DMATX(3,N)*168./DMATX(5,N)
      IF(ATH1-ATH2) 40,50,50
   40 ATHM=ATH2*DMATX(16,N)
      GO TO 60
   50 ATHM=ATH1*DMATX(16,N)
   60 TEMP=SMATX(2,IS1)*SMATX(10,IS1)+SMAT(2)*SMAT(10)
      SMATX(10,OS2)=(TEMP-SMATX(2,OS1)*SMATX(10,OS1))/SMATX(2,OS2)
      TEMP=TEMP/(SMATX(2,IS1)+SMAT(2))
      TEMP1=SMATX(10,OS1)/TEMP
      TEMP2=SMATX(10,CS2)/TEMP
      DO 70 I=3,9
      TEMP3=(SMATX(2,IS1)*SMATX(I,IS1)+SMAT(2)*SMAT(I))/
     . (SMATX(2,IS1)+SMAT(2))
      SMATX(I,OS1)=TEMP1*TEMP3
   70 SMATX(I,OS2)=TEMP2*TEMP3
      DO 80 I=11,17
      SMATX(I,OS1)=(SMATX(I,IS1)*SMATX(2,IS1)+SMAT(I)*SMAT(2))
     . /(SMATX(2,IS1)+SMAT(2))
   80 SMATX(I,OS2)=SMATX(I,OS1)
      ATHM1=ATHM
      XN=0.
      XX=0.
      K=0
      DO 100 I=1,12
      IF(ATHM-Y(I)) 90,90,95
   90 ATHM=Y(I)
      GO TO 110
   95 IF(I-12) 100,96,100
   96 ATHM=Y(12)
  100 CONTINUE
  110 IF(ATHM-25.) 120,120,130
  120 ATHM=25.
      XN=1.
      GO TO 180
```

```
130 IF(ATHM1-1000.) 170,170,140
140 XN=ATHM1/1000.
    K=XN
    XX=K
    IF((XN-XX)*1000.-500.) 150,150,160
150 XN=XX+.5
    GO TO 180
160 XN=XX+1.
    GO TO 180
170 ATHM=ATHM/2.
    XN=2.
180 X=ALOG(ATHM)
    CCOST(N,1)=EXP(1.717538+.453735*X)*1000.*XN
    X=ALOG(ATHM/DMATX(16,N)*XN)
    OHRS=EXP(4.992517-.325053*X+.084026*X**2.)
    XMHRS=EXP(4.832373-.336504*X+.083020*X**2.)
    HPD=EXP(-1.254959+.852347*X)
    ELEC=HPD*4.54*(DMATX(5,N)/7.)
    PWAS=(SMATX(2,IS1)*SMATX(10,IS1)+SMAT(2)*SMAT(10))*8.33
    TMSU=ELEC+PWAS*365./2000.*DMATX(6,N)*DMATX(7,N)
    COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
    OMATX(1,N)=ATHM
    OMATX(2,N)=XN
    OMATX(3,N)=ATHM1
    RETURN
    END
```

MULTIPLE HEARTH INCINERATION

```
      SUBROUTINE MHINC
      INTEGER OS1,OS2
      DIMENSION SFHA(59)
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DATA SFHA/85.,98.,112.,125.,126.,140.,145.,166.,187.,193.,208.,
     . 225.,256.,276.,288.,319.,323.,351.,364.,383.,411.,452.,510.,560.,
     . 575.,672.,760.,845.,857.,944.,988.,1041.,1068.,1117.,1128.,1249.,
     . 1260.,1268.,1400.,1410.,1483.,1540.,1580.,1591.,1660.,1675.,
     . 1752.,1849.,1875.,1933.,2060.,2084.,2090.,2275.,2350.,2464.,
     . 2600.,2860.,3120./
      PSDD=SMATX(10,IS1)*SMATX(2,IS1)*8.33
      FHAT=58.31*SMATX(2,IS1)*SMATX(10,IS1)/DMATX(3,N)/DMATX(1,N)*
     . DMATX(16,N)
      XX=FHAT/DMATX(2,N)
      DO 20 I=1,59
      IF(XX-SFHA(I)) 10,10,20
   10 FHA=SFHA(I)
      GO TO 30
   20 CONTINUE
      FHA=3120.
   30 IF(FHA-200.) 40,40,50
   40 CYT=18.
      GO TO 100
   50 IF(FHA-1700.) 60,60,70
   60 CYT=13.+.024*FHA
      GO TO 100
   70 IF(FHA-2300.) 80,80,90
   80 CYT=.09*(FHA-1100.)
      GO TO 100
   90 CYT=108.
  100 PASH=(SMATX(10,IS1)-SMATX(9,IS1))/SMATX(9,IS1)
      HASH=68.*PASH
      PWAT=(1000000.-SMATX(10,IS1))/SMATX(9,IS1)
      HWSL=1404.3*PWAT
      SAERA=64.03*FHA**.51
      VSPH=SMATX(9,IS1)*SMATX(2,IS1)*58.31/DMATX(3,N)
      HC=1.735*(1.+.374*DMATX(5,N))
      QTRAN=(1.279+HC)*100.*SAERA*DMATX(2,N)/VSPH
      QSEN=3074.
      QCOOL=37.09*1000000./SMATX(9,IS1)
      YSBH=8.*CYT/9.+8736.-52.*DMATX(3,N)
      YHUH=10.*CYT/9.+52.*CYT*DMATX(4,N)/9.
      TEMP=SMATX(9,IS1)*SMATX(2,IS1)*8.33*365.
      QSB=YSBH*315.*FHA*DMATX(2,N)/TEMP
      QHUP=YHUH*1913.*FHA*DMATX(2,N)/TEMP
      QREQ=HASH+HWSL+QCOOL+QTRAN+QSEN+QSB+QHUP
      QNET=QREQ-DMATX(6,N)
      IF(QNET-(QHUP+QSB)) 110,120,120
  110 QNET=QHUP+QSB
  120 IF(DMATX(7,N)-1.) 130,130,140
  130 QFU=14943.
      WF=QNET/QFU
      WFYR=TEMP*WF
      FCOST=WFYR/7.481*DMATX(8,N)
      GO TO 180
  140 IF(DMATX(7,N)-2.) 150,150,160
```

```
150 QFU=15465.
    WF=QNET/QFU
    WFYR=TEMP*WF
    FCOST=WFYR/45.8*DMATX(9,N)
    GO TO 180
160 IF(DMATX(7,N)-3.) 170,170,180
170 QFU=8905.
    WF=QNET/479.
    WFYR=TEMP*WF/1000.
    FCOST=0.
180 TYR=SMATX(10,IS1)*SMATX(2,IS1)*1.52
    WTON=554.24/FHA**.3572
    ECOST=WTON*TYR*DMATX(10,20)
    DPTON=FCOST/(PSDD*365./2000.)
    X=ALOG(PSDD/24.*DMATX(16,N))
    CCOST(N,1)=EXP(2.377364+.598986*X)*1000.
    X=ALOG(PSDD*365./2000.*(SMATX(9,IS1)/SMATX(10,IS1)))
    OHRS=EXP(3.402537+1.215130*X-.157203*X**2.+.009771*X**3.)
    XMHRS=EXP(3.906553+.702471*X-.088337*X**2.+.006827*X**3.)
    TMSU=EXP(7.864729-.338816*X+.054026*X**2.)+ECOST+FCOST
    COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
    OMATX(1,N)=FHA
    OMATX(2,N)=WFYR
    OMATX(3,N)=PSDD
    OMATX(4,N)=ECOST
    OMATX(5,N)=FCOST
    RETURN
    END
```

RAW WASTEWATER PUMPING

```
      SUBROUTINE RWP
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DO 10 I=2,17
   10 SMATX(I,OS1)=SMATX(I,IS1)
      HEAD=DMATX(1,N)
      QP=1.78*SMATX(2,IS1)**.92
      X=ALOG(QP*DMATX(16,N))
      CCOST(N,1)=EXP(4.004828+.519499*X+.082262*X**2.-.006492*X**3.)*
     . 1000.
      X=ALOG(SMATX(2,IS1))
      OHRS=EXP(6.097269+.253066*X-.193659*X**2.+.078201*X**3.-
     . .006680*X**4.)
      XMHRS=EXP(5.911541-.013158*X+.076643*X**2.)
      E12=EXP(6.799199+.785690*X-.087865*X**2.+.042646*X**3.-
     . .004488*X**4.)*(HEAD/30.)
      S12=EXP(5.851743+.301610*X+.197183*X**2.-.017962*X**3.)
      TMSU=E12+S12
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=QP
      RETURN
      END
```

SLUDGE HOLDING TANKS

```
      SUBROUTINE SHT
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DO 10 I=2,17
   10 SMATX(I,OS1)=SMATX(I,IS1)
      QP=1.78*SMATX(2,IS1)**.92
      VSHT=QP*DMATX(1,N)*1000./7.48*DMATX(16,N)
      X=ALOG(VSHT)
      CCOST(N,1)=EXP(2.625751+.484180*X+.000613*X**2.+.002252*X**3.)*
     . 1000.
      V1=SMATX(2,IS1)*DMATX(1,N)*1000./7.48
      X=ALOG(V1)
      OHRS=EXP(5.727345+.000762*X+.098701*X**2.-.006786*X**3.)
      XMHRS=EXP(4.506628+.214662*X+.071402*X**2.-.004681*X**3.)
      TMSU=EXP(5.479939+.299282*X+.106008*X**2.-.008658*X**3.)
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=VSHT
      OMATX(2,N)=QP
      RETURN
      END
```

CENTRIFUGATION

```
      SUBROUTINE CENT
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      HPWK=DMATX(3,N)
      XCEN=DMATX(4,N)
      POLY=DMATX(5,N)
      CPOLY=DMATX(6,N)
      SMATX(7,IS1)=SMATX(7,IS1)+POLY*SMATX(10,IS1)/2000.
      SMATX(10,IS1)=SMATX(10,IS1)+POLY*SMATX(10,IS1)/2000.
      CGPM=SMATX(2,IS1)*116666.7/HPWK*DMATX(16,N)
      DSOL=SMATX(10,IS1)*SMATX(2,IS1)*8.33*365./2000.
      SMATX(10,OS2)=((1.-DMATX(1,N))/(1.-DMATX(1,N)*SMATX(10,IS1)/
     . DMATX(2,N)))*SMATX(10,IS1)
      TEMP1=DMATX(2,N)/SMATX(10,IS1)
      TEMP2=SMATX(10,OS2)/SMATX(10,IS1)
      SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,OS1)=(SMATX(10,IS1)-SMATX(10,OS2))*SMATX(2,IS1)/
     . (SMATX(10,OS1)-SMATX(10,OS2))
      SMATX(2,OS2)=SMATX(2,IS1)-SMATX(2,OS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS1)=SMATX(I,IS1)
   20 SMATX(I,OS2)=SMATX(I,IS1)
      X=ALOG(CGPM)
      CCOST(N,1)=EXP(4.528439+.049867*X+.053198*X**2.)*1000.
      AFC=DMATX(3,20)*(1.+DMATX(3,20))**10./((1.+DMATX(3,20))**10.-1.)
      ACOST(N,1)=CCOST(N,1)*AFC/SMATX(2,1)/3650.
      X=ALOG(DSOL)
      IF(XCEN) 40,30,40
   30 OHRS=EXP(7.621517-.476977*X+.071516*X**2.)
      GO TO 50
   40 OHRS=EXP(7.264153-.466246*X+.069552*X**2.)
   50 XMHRS=EXP(5.997115-.493809*X+.070892*X**2.)
      SUPP=EXP(-2.822519+.700948*X)*1000.
      CHEM=DSOL*POLY*CPOLY
      TMSU=SUPP+CHEM
      COSTO(N,1)=((CHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=CGPM
      OMATX(2,N)=DSOL
      OMATX(3,N)=AFC
      RETURN
      END
```

AEROBIC DIGESTION

```
  SUBROUTINE AEROB
  INTEGER OS1,OS2
  DIMENSION SMAT(20)
  COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
 . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTU(20,5),
 . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
  DO 2 I=1,20
2 SMAT(I)=0.
  IF(IS2) 4,8,4
4 DO 6 I=1,20
6 SMAT(I)=SMATX(I,IS2)
8 L=DMATX(1,N)
  TEMP1=(SMAT(4)*2.13+(SMAT(8)+SMAT(17))*.65*.18)*SMAT(2)
  TEMP2=(OMATX(9,L)*.18+OMATX(10,L)*.0938+OMATX(11,L)+OMATX(12,L))*
 . DMATX(7,L)*SMATX(2,IS1)
  TEMP3=SMAT(7)*SMAT(2)
  TEMP4=OMATX(13,L)*DMATX(7,L)*SMATX(2,IS1)
  SMATX(2,OS1)=((TEMP1+TEMP2+TEMP3+TEMP4)-(SMATX(2,IS1)+
 . SMAT(2))*DMATX(5,N))/(DMATX(4,N)-DMATX(5,N))
  SMATX(2,OS2)=SMATX(2,IS1)+SMAT(2)-SMATX(2,OS1)
  VOLPC=(TEMP1+TEMP2)/(TEMP1+TEMP2+TEMP3+TEMP4)
  SMATX(9,OS1)=DMATX(4,N)*VOLPC
  SMATX(7,OS1)=DMATX(4,N)-SMATX(9,OS1)
  SMATX(3,OS1)=SMATX(9,OS1)/2.13
  SMATX(4,OS1)=SMATX(3,OS1)
  SMATX(5,OS1)=SMATX(3,OS1)/10.
  SMATX(6,OS1)=SMATX(3,OS1)/100.
  SMATX(8,OS1)=0.
  SMATX(10,OS1)=DMATX(4,N)
  SMATX(10,OS2)=DMATX(5,N)
  SMATX(9,OS2)=SMATX(10,OS2)*VOLPC
  SMATX(3,OS2)=SMATX(9,OS2)/2.13
  SMATX(4,OS2)=SMATX(3,OS2)
  SMATX(5,OS2)=SMATX(3,OS2)/10.
  SMATX(6,OS2)=SMATX(3,OS2)/100.
  SMATX(7,OS2)=SMATX(10,OS2)-SMATX(9,OS2)
  SMATX(8,OS2)=50.
  SMATX(11,OS1)=(500.-SMATX(9,OS2)*1.42)/3.2
  SMATX(11,OS2)=SMATX(11,OS1)
  SMATX(12,OS1)=SMATX(11,OS2)/2.
  SMATX(12,OS2)=SMATX(12,OS1)
  ENTN=SMATX(2,IS1)*(SMATX(5,IS1)+SMATX(13,IS1))+SMAT(2)*
 . (SMAT(5)+SMAT(13))
  EXSN=SMATX(2,OS1)*SMATX(5,OS1)+SMATX(2,OS2)*SMATX(5,OS2)
  SMATX(13,OS1)=(ENTN-EXSN)/(SMATX(2,OS1)+SMATX(2,OS2))
  SMATX(13,OS2)=SMATX(13,OS1)
  ENTP=SMATX(2,IS1)*(SMATX(6,IS1)+SMATX(14,IS1))+SMAT(2)*
 . (SMAT(6)+SMATX(14,OS2))
  EXSP=SMATX(2,OS1)*SMATX(6,OS1)+SMATX(2,OS2)*SMATX(6,OS2)
  SMATX(14,OS2)=(ENTP-EXSP)/(SMATX(2,OS1)+SMATX(2,OS2))
  SMATX(14,OS1)=SMATX(14,OS2)
  SMATX(15,OS1)=SMATX(15,IS1)
  SMATX(15,OS2)=SMATX(15,IS1)
  SMATX(16,OS1)=300.
  SMATX(16,OS2)=300.
  SMATX(17,OS1)=DMATX(6,N)-50.
  SMATX(17,OS2)=SMATX(17,OS1)
  VAER1=(SMATX(2,IS1)+SMAT(2))*DMATX(3,N)*1000./7.48*DMATX(16,N)
```

```
      VAER2=(SMATX(2,IS1)*SMATX(10,IS1)+SMAT(2)*SMAT(10))*
     . 8.33/.05/1000.*DMATX(16,N)
      IF(VAER1-VAER2) 10,20,20
   10 VAER=VAER2
      GO TO 30
   20 VAER=VAER1
   30 BSIZE=20.*VAER*DMATX(15,N)
      IF(DMATX(2,N)) 34,32,34
   32 AFS=0.
      GO TO 36
   34 AFS=(SMATX(2,IS1)+SMAT(2))*1000./DMATX(7,N)*DMATX(13,N)
   36 DEMO=(SMATX(9,IS1)*SMATX(2,IS1)+SMAT(9)*SMAT(2)-
     . TEMP1-TEMP2)*8.33*1.5
      CFM=DEMO/.075/.232/.05/1440.*DMATX(15,N)
      IF(BSIZE-CFM) 40,50,50
   40 ACFM=CFM
      GO TO 60
   50 ACFM=BSIZE
   60 QPUMP=(SMATX(2,IS1)+SMAT(2))*DMATX(14,N)*1.5
      X=ALOG(VAER)
      CCOST(N,1)=EXP(2.414380+.175682*X+.084742*X**2.-.002670*X**3.)*
     . 1000.
      OHRS=0.
      XMHRS=0.
      TMSU=0.
      COSTO(N,1)=0.
      X=ALOG(ACFM/1000.)
      CCOST(N,2)=EXP(4.145454+.633339*X+.031939*X**2.-.002419*X**3.)*
     . 1000.
      X=ALOG(ACFM/1000./DMATX(15,N))
      IF(ACFM/1000./DMATX(15,N)-1.) 70,80,80
   70 OHRS=850.
      XMHRS=350.
      GO TO 90
   80 OHRS=EXP(6.900586+.323725*X+.059093*X**2.-.004926*X**3.)
      XMHRS=EXP(6.169937+.294853*X+.175999*X**2.-.040947*X**3.+
     . .003300*X**4.)
   90 HP=ACFM/DMATX(15,N)*8.1*144./(33000.*.8)
      XKW=.8*HP
      XKWPY=XKW*24.*365.
      ECOST=XKWPY*DMATX(10,20)
      SCOST=EXP(.621382+.482047*X)*1000.
      TMSU=ECOST+SCOST
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      IF(DMATX(2,N)) 100,310,100
  100 IF(QPUMP-.5) 190,200,200
  190 CCOST(N,3)=20000.
      GO TO 210
  200 X=ALOG(QPUMP)
      CCOST(N,3)=EXP(3.481553+.377485*X+.093349*X**2.-.006222*X**3.)*
     . 1000.
  210 IF(QPUMP/DMATX(14,N)-.7) 220,230,230
  220 OHRS=400.
      XMHRS=250.
      TMSU=200.+(DMATX(8,N)/30.)*400.
      GO TO 240
  230 X=ALOG(QPUMP/DMATX(14,N))
      OHRS=EXP(6.097269+.253066*X-.193659*X**2.+.078201*X**3.-
    * .006680*X**4.)
      XMHRS=EXP(5.911541-.013158*X+.076643*X**2.)
      E12=EXP(6.799199+.785690*X-.087865*X**2.+.042646*X**3.-
    * .004488*X**4.)*(DMATX(8,N)/30.)
      S12=EXP(5.851743+.301610*X+.197183*X**2.-.017962*X**3.)
      TMSU=E12+S12
  240 COSTO(N,3)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      IF(AFS-1.) 250,260,260
  250 CCOST(N,4)=25000.
      GO TO 270
  260 X=ALOG(AFS)
      CCOST(N,4)=EXP(3.716354+.389861*X+.084560*X**2.-.004718*X**3.)*
    * 1000.
  270 IF(AFS/DMATX(13,N)-1.) 280,290,290
  280 OHRS=300.
      XMHRS=150.
      TMSU=125.
      GO TO 300
  290 X=ALOG(AFS/DMATX(13,N))
      OHRS=EXP(5.846565+.254813*X+.113703*X**2.-.010942*X**3.)
      XMHRS=EXP(5.273419+.228329*X+.122646*X**2.-.011672*X**3.)
      TMSU=EXP(5.669881+.750799*X)
  300 COSTO(N,4)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
  310 OMATX(1,N)=VAER
      OMATX(2,N)=ACFM
      OMATX(3,N)=QPUMP
      OMATX(4,N)=AFS
      RETURN
      END
```

POST AERATION

```
      SUBROUTINE POSTA
      INTEGER OS1,OS2
      DIMENSION SIZE(14)
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DATA SIZE/5.,7.5,10.,15.,20.,25.,30.,40.,50.,60.,75.,100.,
     . 125.,150./
      ITYPE=DMATX(1,N)
      L=DMATX(2,N)
      DOIN=DMATX(3,N)
      DOUT=DMATX(4,N)
      TL=DMATX(5,N)
      TD=DMATX(6,N)
      TW=DMATX(7,N)
      AERFO=DMATX(8,N)
      HPHRO=DMATX(9,N)
      ALT=DMATX(10,N)
      CFMDF=DMATX(11,N)
      DIFFT=DMATX(12,N)
      DD=DMATX(13,N)
      IF(7.5-DOUT) 2,4,4
    2 WRITE(IO,3)
    3 FORMAT(////,10X,'DEMAND DOUT OF POST AERATION IS TOO HIGH',////)
    4 CAER=.024
      CY=.65
      CE=.125
      ALPHA=.9
      BETA=.95
      S=SMATX(8,IS1)+SMATX(17,IS1)
      XA=OMATX(9,L)*OMATX(3,L)
      CFM=0.
      HP=0.
      CFMMG=0.
      HPMG=0.
      DEPTH=0.
      TMIN=0.
      VAER=0.
      VMG=0.
      VCF=0.
      VDEL=0.
      WIDTH=0.
      AERFF=0.
      CLEN=0.
      VFM=0.
      TLEN=0.
      HP1=0.
      XN=0.
      THP=0.
      DO 5 I=2,17
    5 SMATX(I,OS1)=SMATX(I,IS1)
      CSS=14.652-.410220*TL+.007991*TL**2.-.000078*TL**3.
      RP=(760.-.025*ALT)/760.
      CSW=RP*CSS*BETA
      IF(ITYPE) 10,40,50
   10 VMG=0.
      AERK1=.31942*(CSW-DOUT)*HPHRO*ALPHA*1.025**(TL-20.)
      AERK2=.58*CAER*XA*S/CY+1.16*CE*XA
   NT=0
20 NT=NT+1
   HP=(SMATX(2,IS1)*(DOUT-DOIN)+AERK2*VMG)/AERK1*DMATX(15,N)
   VCF=(17.+.53*HP)**2.*(5.+.07*HP)
   VMGP=VMG
   VMG=VCF*7.48/1000000.*DMATX(16,N)
   VDEL=ABS(VMG-VMGP)
   IF(NT-25) 26,26,24
24 WRITE(IO,25)
25 FORMAT(////,10X,'POST AERATION ITERATION DOES NOT CONVERGE',////)
   GO TO 30
26 IF(VDEL-.0001) 30,30,20
30 DO 34 I=1,14
   IF(HP-SIZE(I)) 32,32,34
32 HP1=SIZE(I)
   XN=1.
   GO TO 36
34 CONTINUE
   HP1=150.
   XN=HP/150.
   IXN=XN
   XN=IXN+1
36 THP=HP1*XN
   WIDTH=17.+.53*HP1
   DEPTH=5.+.07*HP1
   VCF=DEPTH*WIDTH**2.
   VMG=(VCF*7.48/1000000.)*XN
   HPMG=THP/VMG
   DAYS=VMG/SMATX(2,IS1)
   TMIN=DAYS*1440.
   VAER=VMG*1000./7.48
   GO TO 60
40 CFMMG=CFMDF*DIFFT*1000000./TD/TW/7.48
   AERFF=AERFO*(DD/13.)**.66666*(8./CFMDF)**.2
   AERK1=.33347*CFMMG*AERFF*ALPHA*1.025**(TL-20.)
   AERK2=.58*CAER*XA*S/CY-1.16*CE*XA
   TEMP=(AERK1*(CSW-DOUT)-AERK2)/(AERK1*(CSW-DOIN)-AERK2)
   DAYS=-1.*ALOG(TEMP)/AERK1
   TMIN=DAYS*1440.
   VFM=SMATX(2,IS1)*38.76/TD/TW
   CLEN=VFM*TMIN
   CFM=CLEN*CFMDF*DIFFT*DMATX(15,N)
   GO TO 60
50 CFMMG=CFMDF*DIFFT*1000000./TD/TW/7.48
   AERFF=AERFO*(DD/13.)**.66666*(8./CFMDF)**.2
   AERK1=.33347*CFMMG*AERFF*ALPHA*1.025**(TL-20.)
   AERK2=.58*CAER*XA*S/CY-1.16*CE*XA
   VMG=SMATX(2,IS1)*(DOUT-DOIN)/(AERK1*(CSW-DOUT)-AERK2)*DMATX(16,N)
   DAYS=VMG/SMATX(2,IS1)
   TMIN=DAYS*1440.
   TLEN=VMG*1000000./TD/TW/7.48
   VAER=VMG*1000./7.48
   CFM=CFMMG*VMG*DMATX(15,N)
60 IF(ITYPE) 62,68,62
62 X=ALOG(VAER)
   CCOST(N,1)=EXP(2.180040+.351346*X+.064188*X**2.-.003403*X**3.)*
  . 1000.
   OHRS=0.
```

```
      XMHRS=0.
      TMSU=0.
      COSTO(N,1)=0.
   68 IF(ITYPE) 70,80,80
   70 X=ALOG(THP)
      IF(THP-20.) 72,74,74
   72 CCOST(N,2)=20000.
      GO TO 76
   74 CCOST(N,2)=EXP(2.848804-.223685*X+.142476*X**2.-.005985*X**3.)*
     * 1000.
   76 X=ALOG(THP/DMATX(15,N))
      IF(THP/DMATX(15,N)-40.) 77,78,78
   77 OHRS=600.
      XMHRS=300.
      GO TO 79
   78 OHRS=EXP(6.716272-.310684*X+.112744*X**2.-.004877*X**3.)
      XMHRS=EXP(4.251092+.467681*X+.008276*X**2.)
   79 XKW=.8*THP/DMATX(15,N)
      XKWPY=XKW*24.*365.
      ECOST=XKWPY*DMATX(10,20)
      PCFM=THP/DMATX(15,N)/8.1/144.*(33000.*.8)/1000.
      SCOST=EXP(.621382+.482047*ALOG(PCFM))*1000.
      TMSU=ECOST+SCOST
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      GO TO 90
   80 X=ALOG(CFM/1000.)
      IF(CFM/1000.-.1) 82,84,84
   82 CCOST(N,2)=13000.
      GO TO 86
   84 CCOST(N,2)=EXP(4.145454+.633339*X+.031939*X**2.-.002419*X**3.)*
     * 1000.
   86 X=ALOG(CFM/1000./DMATX(15,N))
      IF(CFM/1000./DMATX(15,N)-1.) 87,88,88
   87 OHRS=850.
      XMHRS=350.
      GO TO 89
   88 OHRS=EXP(6.900586+.323725*X+.059093*X**2.-.004926*X**3.)
      XMHRS=EXP(6.169937+.294853*X+.175999*X**2.-.040947*X**3.+
     * .003300*X**4.)
   89 CHP=CFM/DMATX(15,N)*8.1*144./(33000.*.8)
      XKW=.8*CHP
      XKWPY=XKW*24.*365.
      ECOST=XKWPY*DMATX(10,20)
      SCOST=EXP(.621382+.482047*X)*1000.
      TMSU=ECOST+SCOST
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
   90 OMATX(1,N)=VAER
      OMATX(2,N)=CFM
      OMATX(3,N)=HP
      OMATX(4,N)=TMIN
      OMATX(5,N)=VMG
      OMATX(6,N)=AERFF
      OMATX(7,N)=CLEN
      OMATX(8,N)=HP1
      OMATX(9,N)=XN
      OMATX(10,N)=THP
      OMATX(11,N)=WIDTH
      OMATX(12,N)=DEPTH
      OMATX(13,N)=TLEN
      RETURN
      END
```

EQUALIZATION

```
      SUBROUTINE EQUAL
      INTEGER OS1,OS2
      DIMENSION SIZE(14)
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DATA SIZE/5.,7.5,10.,15.,20.,25.,30.,40.,50.,60.,75.,100.,
     . 125.,150./
      VAER=0.
      ECFM=0.
      PLAND=0.
      CLAND=0.
      HP=0.
      HP1=0.
      XN=0.
      THP=0.
      IAER=DMATX(1,N)
      RLW=DMATX(2,N)
      COSTL=DMATX(3,N)
      HEAD=DMATX(4,N)
      IMAT=DMATX(5,N)
      QP=1.78*SMATX(2,IS1)**.92
      VU=SMATX(2,IS1)*.12*1000000./7.48*DMATX(16,N)
      IF(IMAT) 25,5,25
    5 IF(VU-39000.) 10,10,20
   10 VU=39000.
      WIDTH=90.
      AREA=.18595
      VMIN=1500.
      SAREA=(2.*WIDTH*(1.+RLW)-156.)*53.76+(WIDTH-90.)*(RLW*WIDTH-90.)+
     . 20.*(24.+(1.+RLW)*WIDTH)
      GO TO 30
   20 WIDTH=(300.*(1.+RLW)+(90000.*(1.+RLW)**2.-40.*RLW*(12000.-VU))
     . **.5)/20./RLW
      AREA=RLW*WIDTH**2./43560.
      VMIN=5.*RLW*WIDTH**2.-375.*WIDTH*(1.+RLW)+28500.
      SAREA=(2.*WIDTH*(1.+RLW)-156.)*53.76+(WIDTH-90.)*(RLW*WIDTH-90.)+
     . 20.*(24.+(1.+RLW)*WIDTH)
      GO TO 30
   25 WIDTH=(300.*(1.+RLW)+(90000.*(1.+RLW)**2.-40.*RLW*(12000.-VU))
     . **.5)/20./RLW
      AREA=RLW*WIDTH**2./43560.
      VMIN=VU*.2857
      SAREA=0.
   30 VUMG=VU*7.48/1000000.
      VOMG=VMIN*7.48/1000000.
      VT=VUMG+VOMG
      IF(IMAT) 92,35,92
   35 IF(VT-1.4) 50,50,40
   40 HPA=VT*29.88
      GO TO 60
   50 HPA=VT*35.36/(VT**.5)
   60 HPB=VT*59./(VT**.4254)
      IF(HPA-HPB) 62,64,64
   62 HP=HPB*DMATX(15,N)
      GO TO 66
   64 HP=HPA*DMATX(15,N)
   66 DO 80 I=1,14
```

```
     IF(HP-SIZE(I)) 70,70,80
 70  HP1=SIZE(I1
     XN=1
     GO TO 90
 80  CONTINUE
     HP1=150.
     XN=HP/150.
     IXN=XN
     XN=IXN+1
 90  THP=HP1*XN
 92  X=ALOG(SMATX(2,IS1)*DMATX(14,N))
     CCOST(N,3)=EXP(3.481553+.377485*X+.093349*X**2.-.006222*X**3.)*
    . 1000.
     X=ALOG(SMATX(2,IS1))
     OHRS=EXP(6.097269+.253066*X-.193659*X**2.+.078201*X**3.-
    . .006680*X**4.)
     XMHRS=EXP(5.911541-.013158*X+.076643*X**2.)
     E12=EXP(6.799199+.785690*X-.087865*X**2.+.042646*X**3.-
    . .004488*X**4.)*HEAD/30.
     S12=EXP(5.851743+.301610*X+.197183*X**2.-.017962*X**3.)
     TMSU=E12+S12
     COSTO(N,3)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
     X=ALOG(SMATX(2,IS1)*DMATX(14,N))
     CCOST(N,4)=EXP(8.109253+.646743*X)
     COSTO(N,4)=0.
     IF(IMAT) 95,100,95
 95  VOMG=0.
     VT=VUMG
     VAER=VT*1000./7.48
     X=ALOG(VAER)
     CCOST(N,1)=EXP(2.414380+.175682*X+.084742*X**2.-.002670*X**3.)*
    . 1000.
     COSTO(N,1)=0.
     ECFM=20.*VAER*DMATX(15,N)
     X=ALOG(ECFM/1000.)
     CCOST(N,2)=EXP(4.145454+.633339*X+.031939*X**2.-.002419*X**3.)*
    . 1000.
     X=ALOG(ECFM/1000./DMATX(15,N))
     OHRS=EXP(6.900586+.323725*X+.059093*X**2.-.004926*X**3.)
     XMHRS=EXP(6.169937+.294853*X+.175999*X**2.-.040947*X**3.+
    . .003300*X**4.)
     EHP=ECFM/DMATX(15,N)*8.1*144./(33000.*.8)
     XKW=.8*EHP
     XKWPY=XKW*24.*365.
     ECOST=XKWPY*DMATX(10,20)
     SCOST=EXP(.621382+.482047*X)*1000.
     TMSU=ECOST+SCOST
     COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
     GO TO 190
100  X=ALOG(AREA)
     IF(AREA-1.) 105,110,110
105  CCOST(N,1)=22000.
     OHRS=600.
     XMHRS=100.
     GO TO 120
110  CCOST(N,1)=EXP(3.501091+.422086*X+.079097*X**2.-.008338*X**3.)*
    . 1000.
     OHRS=EXP(6.547042+.262634*X+.058298*X**2.-.013454*X**3.+
     . .001494*X**4.)
      XMHRS=EXP(4.844423+.327982*X+.017677*X**2.)
  120 TMSU=0.
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      X=ALOG(THP)
      IF(IAER) 140,130,140
  130 CCOST(N,2)=EXP(.647120+.438812*X+.031192*X**2.)*1000.
      GO TO 150
  140 CCOST(N,2)=EXP(3.141014-.218751*X+.136739*X**2.-.006042*X**3.)*
     . 1000.
  150 X=ALOG(THP/DMATX(15,N))
      OHRS=0.
      XMHRS=0.
      XKW=.8*THP/DMATX(15,N)
      XKWPY=XKW*24.*365.
      ECOST=XKWPY*DMATX(10,20)
      SCOST=EXP(4.016957+.534211*X)
      TMSU=ECOST+SCOST
      COSTO(N,2)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      CCOST(N,5)=SAREA*COSTL
      COSTO(N,5)=0.
      X=ALOG(AREA)
      PLAND=EXP(1.588306+.529246*X+.038611*X**2.)
      CLAND=PLAND*DMATX(7,20)
  190 DO 200 I=2,17
  200 SMATX(I,OS1)=SMATX(I,IS1)
      OMATX(1,N)=WIDTH
      OMATX(2,N)=AREA
      OMATX(3,N)=VUMG
      OMATX(4,N)=VCMG
      OMATX(5,N)=VT
      OMATX(6,N)=SAREA
      OMATX(7,N)=HP
      OMATX(8,N)=HP1
      OMATX(9,N)=XN
      OMATX(10,N)=THP
      OMATX(11,N)=PLAND
      OMATX(12,N)=CLAND
      OMATX(13,N)=VAER
      OMATX(14,N)=ECFM
      RETURN
      END
```

SECOND STAGE ANAEROBIC DIGESTION

```
      SUBROUTINE DIG2
      INTEGER OS1,CS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      VDIG=DMATX(3,N)*SMATX(2,IS1)*133.69*DMATX(16,N)
      SMATX(10,OS2)=((1.-DMATX(1,N))/(1.-DMATX(1,N)*SMATX(10,IS1)/
     . DMATX(2,N)))*SMATX(10,IS1)
      TEMP1=DMATX(2,N)/SMATX(10,IS1)
      TEMP2=SMATX(10,OS2)/SMATX(10,IS1)
      SMATX(10,OS1)=DMATX(2,N)
      SMATX(2,OS1)=(SMATX(10,IS1)-SMATX(10,OS2))*SMATX(2,IS1)/
     . (SMATX(10,OS1)-SMATX(10,OS2))
      SMATX(2,OS2)=SMATX(2,IS1)-SMATX(2,OS1)
      DO 10 I=3,9
      SMATX(I,OS1)=TEMP1*SMATX(I,IS1)
   10 SMATX(I,OS2)=TEMP2*SMATX(I,IS1)
      DO 20 I=11,17
      SMATX(I,OS1)=SMATX(I,IS1)
   20 SMATX(I,OS2)=SMATX(I,IS1)
      X=ALOG(VDIG)
      IF(VDIG-20.) 22,25,25
   22 CCOST(N,1)=EXP(4.594215+.127244*X-.004001*X**2.)*1000.
      GO TO 28
   25 CCOST(N,1)=EXP(7.679634-1.949689*X+.402610*X**2.-.018211*X**3.)*
     . 1000.
   28 X=ALOG(VDIG/DMATX(16,N))
      IF(VDIG-20.) 30,40,40
   30 OHRS=EXP(6.163803+.166305*X-.012470*X**2.)
      XMHRS=EXP(5.726981+.113674*X)
      TMSU=EXP(6.531623+.198417*X+.021660*X**2.)
      GO TO 50
   40 OHRS=EXP(9.129250-1.816736*X+.373282*X**2.-.017290*X**3.)
      XMHRS=EXP(8.566752-1.768137*X+.363173*X**2.-.016620*X**3.)
      TMSU=EXP(8.702803-1.182711*X+.282691*X**2.-.013672*X**3.)
   50 COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=VDIG
      RETURN
      END
```

LAND DISPOSAL OF LIQUID SLUDGE BY TRUCKING

```
      SUBROUTINE LANDD
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      TAYR=DMATX(1,N)
      SP=DMATX(2,N)
      DIST=DMATX(3,N)
      TS=DMATX(4,N)
      YRSL=DMATX(5,N)
      TYT=260.*8./(.04*DIST+.5)
      TTYR=365.*SMATX(2,IS1)*1000000./TS
      TRKN=TTYR/TYT
      NNN=TRKN*DMATX(15,N)
      TRKN=NNN+1
      SLV=SP*365.*SMATX(2,IS1)*1000000./7.48/1000.*DMATX(16,N)
      TONS=(SMATX(10,IS1)+SMATX(15,IS1))*SMATX(2,IS1)*8.33*365./2000.
      ALAND=TONS/TAYR
      COL=ALAND*DMATX(7,20)
      DLAND=COL*DMATX(3,20)
      AF=DMATX(3,20)*(1.+DMATX(3,20))**DMATX(4,20)/((1.+DMATX(3,20))**
     . DMATX(4,20)-1.)
      AFT=DMATX(3,20)*(1.+DMATX(3,20))**YRSL/((1.+DMATX(3,20))**YRSL-1.)
      IF(SLV) 10,15,10
   10 X=ALOG(SLV)
      CCOST(N,1)=EXP(.375449+.394996*X+.014726*X**2.)*1000.
      X=ALOG(TONS)
      OHRS=EXP(6.567594-.971759*X+.095689*X**2.)
      XMHRS=EXP(-2.087393+2.395831*X-.340388*X**2.+.017499*X**3.)
      TMSU=0.
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
   15 X=ALOG(TS/1000.)
      CCOST(N,2)=EXP(1.317230+3.959678*X-2.592107*X**2.+.583467*X**3.)*
     . (1.506/1.761)*1000.*TRKN
      ACOST(N,2)=CCOST(N,2)*AFT/SMATX(2,1)/3650.
      IF(TS-5500.) 20,50,50
   20 IF(TS-2500.) 30,40,40
   30 OM=.23*DIST*TTYR
      GO TO 60
   40 OM=.35*DIST*TTYR
      GO TO 60
   50 OM=.40*DIST*TTYR
   60 TMHR=TTYR*(.04*DIST+.5)
      COSTO(N,2)=(TMHR*DHR*(1.+PCT)+OM*WPI)/SMATX(2,1)/3650.
      CCOST(N,3)=0.
      COSTO(N,3)=DLAND/SMATX(2,1)/3650.
      OMATX(1,N)=TYT
      OMATX(2,N)=TTYR
      OMATX(3,N)=TRKN
      OMATX(4,N)=SLV
      OMATX(5,N)=TONS
      OMATX(6,N)=ALAND
      OMATX(7,N)=DLAND
      OMATX(8,N)=COL
      OMATX(9,N)=AFT
      RETURN
      END
```

LIME ADDITION TO SLUDGE

```
      SUBROUTINE LIME
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      DLIME=DMATX(1,N)
      CLIME=DMATX(2,N)
      DTON=(SMATX(10,IS1)+SMATX(15,IS1))*SMATX(2,IS1)*8.33/2000.
      PPDL=DLIME*DTON
      DO 10 I=2,6
   10 SMATX(I,OS1)=SMATX(I,IS1)
      SMATX(7,OS1)=SMATX(7,IS1)+PPDL/8.33/SMATX(2,IS1)
      SMATX(8,OS1)=SMATX(8,IS1)
      SMATX(9,OS1)=SMATX(9,IS1)
      SMATX(10,OS1)=SMATX(10,IS1)+PPDL/8.33/SMATX(2,IS1)
      DO 20 I=11,17
   20 SMATX(I,OS1)=SMATX(I,IS1)
      X=ALOG(PPDL)
      CCOST(N,1)=EXP(-1.800487+.670797*X)*1000.
      X=ALOG(PPDL/DMATX(16,N))
      OHRS=0.
      XMHRS=EXP(6.060054+.197073*X)
      TMSU=PPDL*365.*CLIME/2000.
      COSTO(N,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      OMATX(1,N)=PPDL
      OMATX(2,N)=DTON
      RETURN
      END
```

CALCULATE TOTAL PLANT COSTS

```
      SUBROUTINE COST
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      CCI=DMATX(1,20)
      RI=DMATX(3,20)
      YRS=DMATX(4,20)
      DA=DMATX(7,20)
      CCINT=DMATX(8,20)
      XLAB=DMATX(9,20)
      CCI=CCI/1.506
      AF=RI*(1.+RI)**YRS/((1.+RI)**YRS-1.)
      X=ALOG(SMATX(2,1))
      CCOST(20,1)=EXP(3.524005+.383129*X+.077688*X**2.-.009021*X**3.)*
     . 1000.
      OHRS=EXP(5.886104+.778820*X)
      XMHRS=EXP(4.605170+.661110*X)
      TMSU=EXP(7.244226+.500000*X)
      COSTO(20,1)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      CCOST(20,2)=EXP(2.288450+.446606*X+.032729*X**2.)*1000.
      OHRS=0.
      XMHRS=0.
      TMSU=0.
      COSTO(20,2)=0.
      CCOST(20,3)=0.
      IF(XLAB) 4,2,4
    2 OHRS=EXP(6.551080+.447632*X)
      GO TO 6
    4 OHRS=EXP(7.892489+.087261*X+.004753*X**2.+.006532*X**3.)
    6 XMHRS=EXP(4.700480+.368379*X)
      TMSU=EXP(5.972471+.534838*X+.010941*X**2.+.010320*X**3.)
      COSTO(20,3)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      CCOST(20,4)=0.
      OHRS=0.
      XMHRS=EXP(6.542359+.082452*X+.184209*X**2.-.013606*X**3.)
      TMSU=EXP(5.991464+.650515*X)
      COSTO(20,4)=((OHRS+XMHRS)*DHR*(1.+PCT)+TMSU*WPI)/SMATX(2,1)/3650.
      TCAP=0.
      DO 11 J=1,20
      DO 11 I=1,5
      CCOST(J,I)=CCOST(J,I)*CCI/1000.
   11 TCAP=TCAP+CCOST(J,I)
      YARD=.14*TCAP
      TCC=ALOG(TCAP+YARD)
      FLOW=ALOG(SMATX(2,1))
      XLAND=EXP(2.405815+.010392*FLOW+.127563*FLOW**2.-.009133*FLOW**3.)
     . *DA/1000.+CLAND/1000.+DLAND/1000.
      ENG=EXP(.557449+.462790*TCC+.021284*TCC**2.)
      SUBT1=ALOG(TCAP+YARD+XLAND+ENG)
      FISC=EXP(-2.497954+.916338*SUBT1-.023887*SUBT1**2.)
      SUBT2=ALOG(TCAP+YARD+XLAND+ENG+FISC)
      P=-1.475131+.428894*SUBT2
      XINT=CCINT*P/2.*EXP(SUBT2)
      TOT=TCAP+YARD+XLAND+ENG+FISC+XINT
      TCC=EXP(TCC)
      SUBT1=EXP(SUBT1)
      SUBT2=EXP(SUBT2)
```

CALCULATE TOTAL PLANT COSTS

```
      TCAP=TCAP*1000.
      TOT=TOT*1000.
      YARD=YARD*1000.
      TCC=TCC*1000.
      XLAND=XLAND*1000.
      ENG=ENG*1000.
      SUBT1=SUBT1*1000.
      FISC=FISC*1000.
      SUBT2=SUBT2*1000.
      XINT=XINT*1000.
      RATIO=TOT/TCAP
      ACRE=(XLAND-DLAND)/DA
      TOT=0.
      TAMM=0.
      TOPER=0.
      TOTAL=0.
      DO 20 J=1,20
      DO 20 I=1,5
      CCOST(J,I)=CCOST(J,I)*1000.*RATIO
      IF(ACOST(J,I)) 14,16,14
   14 ACOST(J,I)=ACOST(J,I)*RATIO*CCI
      GO TO 18
   16 ACOST(J,I)=CCOST(J,I)*AF/SMATX(2,1)/3650.
   18 TCOST(J,I)=COSTO(J,I)+ACOST(J,I)
      TOT=TOT+CCOST(J,I)
      TAMM=TAMM+ACOST(J,I)
      TOPER=TOPER+COSTO(J,I)
   20 TOTAL=TOTAL+TCOST(J,I)
      DMATX(1,20)=CCI*1.506
      DMATX(2,20)=WPI*1.122
      OMATX(1,20)=RATIO
      OMATX(2,20)=TCAP
      OMATX(3,20)=YARD
      OMATX(4,20)=TCC
      OMATX(5,20)=XLAND
      OMATX(6,20)=ENG
      OMATX(7,20)=SUBT1
      OMATX(8,20)=FISC
      OMATX(9,20)=SUBT2
      OMATX(10,20)=XINT
      OMATX(11,20)=ACRE
      OMATX(12,20)=AF
      OMATX(17,20)=TOT
      OMATX(18,20)=TAMM
      OMATX(19,20)=TOPER
      OMATX(20,20)=TOTAL
      RETURN
      END
```

PRINT OUTPUT

```
      SUBROUTINE PRINT
      INTEGER OS1,OS2
      COMMON SMATX(20,30),TMATX(20,30),DMATX(20,20),OMATX(20,20),IP(20),
     . INP,IO,IS1,IS2,OS1,OS2,N,IAERF,CCOST(20,5),COSTO(20,5),
     . ACOST(20,5),TCOST(20,5),DHR,PCT,WPI,CLAND,DLAND
      WRITE(IO,10)
   10 FORMAT(1H1,//,49X,'STREAM CHARACTERISTICS',//,66X,'VOLUME FLOW, MI
     .LLIONS OF GALLONS PER DAY',/,66X,'CONCENTRATIONS, MILLIGRAMS PER L
     .ITER',/)
      DO 40 I=1,30
      IF(SMATX(1,I)) 20,40,20
   20 WRITE(IO,30) (SMATX(J,I),J=1,9),SMATX(16,I),(SMATX(J,I),J=11,15),
     . SMATX(17,I),SMATX(10,I)
   30 FORMAT(13X,'S',F3.0,9X,'Q',8X,'SOC',7X,'SNBC',8X,'SON',8X,'SOP',
     . 8X,'SFM',7X,'SBOD',8X,'VSS',/,18X,8F11.3,/,24X,'ALK',8X,'DOC',
     . 7X,'DNBC',9X,'DN',9X,'DP',8X,'DFM',7X,'DBOD',8X,'TSS',/,
     . 18X,8F11.3,//)
   40 CONTINUE
      WRITE(IO,80)
   80 FORMAT(1H1,//,44X,'PROCESS CHARACTERISTICS',//,58X,'CCOST = CAPITA
     .L COST, DOLLARS',/,58X,'COSTO = OPERATING + MAINTENANCE COST, CENT
     .S/1000 GAL.',/,58X,'ACOST = AMORTIZATION COST, CENTS/1000 GAL.',/,
     .58X,'TCOST = TOTAL TREATMENT COST, CENTS/1000 GAL.',//)
      DO 1500 I=1,20
      IF(IP(I)) 90,1500,90
   90 KK=IP(I)
      GO TO (100,150,200,1500,1500,250,300,350,400,450,500,550,
     . 600,650,700,750,800,850,900,950,1000,1050,1100),KK
  100 WRITE(IO,110) I,DMATX(1,I),CCOST(I,1),COSTO(I,1),ACOST(I,1),
     . TCOST(I,1),DMATX(16,I)
  110 FORMAT(1X,1HP,I2,2X,'PRELIMINARY',6X,'IPREL',40X,'CCOST',4X,
     . 'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,6X,'TREATMENT',6X,
     . F9.1,36X,F9.0,3F9.3,F9.2,//)
      GO TO 1500
  150 WRITE(IO,160) I,(DMATX(J,I),J=1,3),(OMATX(J,I),J=1,3),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
     . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I)
  160 FORMAT(1X,1HP,I2,2X,'PRIMARY',11X,'FRPS',5X,'URPS',5X,'HPWK',6X,
     . 'GPS',6X,'APS',5X,'PGPM',/,6X,'SEDIMENTATION',2X,F9.2,3F9.1,F9.3,
     . F9.0,//,68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,
     . 'ECF',/,57X,'SETTLER',2X,F9.0,3F9.3,F9.2,//,57X,'SLUDGE',3X,
     . F9.0,3F9.3,F9.2,/,57X,'PUMPS',//)
      GO TO 1500
  200 WRITE(IO,210) I,(DMATX(J,I),J=1,10),(OMATX(J,I),J=1,10)
  210 FORMAT(1X,1HP,I2,2X,'AERATOR-',11X,'BOD',5X,'MLSS',5X,'DEGC',3X,
     . 'CAER20',7X,'DO',3X,'AEFF20',5X,'URSS',6X,'GSS',5X,'HEAD',5X,
     . 'ALMD',/,6X,'FINAL SETTLER',2X,F9.1,F9.0,8F9.2,//,24X,'BOD2',4X,
     . 'DOSAT',5X,'XRSS',6X,'AFS',5X,'CAER',5X,'CEDR',5X,'VAER',5X,
     . 'VNIT',4X,'MLASS',4X,'MLBSS',/,21X,2F9.1,F9.4,2F9.2,3F9.3,2F9.0/)
      WRITE(IO,220) (OMATX(J,I),J=11,20),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
     . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I),
     . CCOST(I,3),COSTO(I,3),ACOST(I,3),TCOST(I,3),DMATX(14,I),
     . CCOST(I,4),COSTO(I,4),ACOST(I,4),TCOST(I,4),DMATX(13,I)
  220 FORMAT(22X,'MLNBSS',4X,'MLDSS',4X,'MLISS',5X,'FOOD',4X,'RTURN',5X,
     . 'CNIT',4X,'ARCFD',4X,'BSIZE',4X,'CFPGL',7X,'QR',/,21X,3F9.0,F9.1,
     . 2F9.3,2F9.0,F9.2,F9.3,//,68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,
     . 'TCOST',6X,'ECF',/,57X,'AERATOR',2X,F9.0,3F9.3,F9.2,//,57X,
    . 'BLOWER',3X,F9.0,3F9.3,F9.2,//,57X,'SLUDGE',3X,F9.0,3F9.3,F9.2,/,
    . 57X,'PUMPS',//,57X,'FINAL',4X,F9.0,3F9.3,F9.2,/,57X,'SETTLER',//)
     GO TO 1500
250 WRITE(IO,260) I,(DMATX(J,I),J=1,2),(OMATX(J,I),J=1,5),
    . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
260 FORMAT(1X,1HP,I2,2X,'ANAEROBIC',11X,'TD',5X,'TDIG',4X,'C1DIG',
    . 4X,'C2DIG',5X,'VDIG',6X,'CH4',6X,'CO2',/,6X,'DIGESTION',6X,
    . 2F9.1,F9.3,4F9.0,//,68X,'CCOST',4X,'COSTO',4X'ACOST',4X,
    . 'TCOST',6X,'ECF',/,66X,F9.0,3F9.3,F9.2,//)
     GO TO 1500
300 WRITE(IO,310) I,(DMATX(J,I),J=1,8),(OMATX(J,I),J=1,3),
    . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
310 FORMAT(1X,1HP,I2,2X,'VACUUM',13X,'VFL',5X,'HPWK',6X,'TSS',
    . 4X,'IVACF',7X,'FE',6X,'CAO',6X,'CFE',5X,'CCAO',/,6X,'FILTRATION',
    . 5X,F9.2,2F9.0,F9.1,2F9.2,2F9.4,//,21X,'WP',6X,'AVF',5X,'PSDD',
    . 22X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,21X,
    . 2F9.1,F9.0,18X,F9.0,3F9.3,F9.2,//)
     GO TO 1500
350 WRITE(IO,360) I,(DMATX(J,I),J=1,4),(OMATX(J,I),J=1,2),
    . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
360 FORMAT(1X,1HP,I2,2X,'GRAVITY',12X,'TRR',6X,'TSS',6X,'GTH',5X,
    . 'GSTH',5X,'ATHM',6X,'WRT',/,6X,'THICKENING',5X,F9.2,F9.0,3F9.1,
    . F9.2,//,68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',
    . /,66X,F9.0,3F9.3,F9.2,//)
     GO TO 1500
400 WRITE(IO,410) I,(DMATX(J,I),J=1,5),OMATX(1,I),CCOST(I,1),
    . COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
410 FORMAT(1X,1HP,I2,2X,'ELUTRIATION',8X,'ERR',6X,'TSS',6X,'WRE',
    . 7X,'GE',6X,'GES',7X,'AE',/,21X,F9.2,F9.0,3F9.1,F9.0,//,68X,
    . 'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,66X,
    . F9.0,3F9.3,F9.2,//)
     GO TO 1500
450 WRITE(IO,460) I,(DMATX(J,I),J=1,3),OMATX(1,I),CCOST(I,1),
    . COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
460 FORMAT(1X,1HP,I2,2X,'SLUDGE DRYING',6X,'SBL',5X,'SOUT',6X,
    . 'TSS',6X,'ASB',13X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',
    . 6X,'ECF',/,6X,'BEDS',11X,F9.6,F9.2,2F9.0,9X,F9.0,3F9.3,F9.2,//)
     GO TO 1500
500 WRITE(IO,510) I,(DMATX(J,I),J=1,9),(OMATX(J,I),J=1,4)
510 FORMAT(1X,1HP,I2,2X,'TRICKLING',10X,'BOD',5X,'DEGC',7X,'HQ',4X,
    . 'SAREA',5X,'URSS',5X,'XRSS',3X,'RECYCL',6X,'GSS',5X,'HEAD',/,
    . 6X,'FILTER-',8X,F9.1,4F9.2,F9.4,3F9.1,/,6X,'FINAL SETTLER',/,
    . 25X,'AFS',6X,'VOL',4X,'FAREA',4X,'DEPTH',/,21X,F9.2,2F9.0,F9.2,/)
     WRITE(IO,520)
    . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
    . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I),
    . CCOST(I,3),COSTO(I,3),ACOST(I,3),TCOST(I,3),DMATX(14,I)
520 FORMAT(68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,
    . 57X,'FILTER',3X,F9.0,3F9.3,F9.2,//,57X,'FINAL',4X,F9.0,3F9.3,
    . F9.2,/,57X,'SETTLER',//,57X,'SLUDGE',3X,F9.0,3F9.3,F9.2,/,
    . 57X,'PUMPS',//)
     GO TO 1500
550 WRITE(IO,560) I,(DMATX(J,I),J=1,2),
    . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
    . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I)
560 FORMAT(1X,1HP,I2,2X,'CHLORINATION',6X,'DCL2',5X,'TCL2',31X,
    . 'CCOST',4X,'COSTO',4X'ACOST',4X,'TCOST',6X,'ECF',/,21X,
    . 2F9.1,18X,'FEED',5X,F9.0,3F9.3,F9.2,/,57X,'SYSTEM',//,57X,
     . 'CONTACT',2X,F9.0,3F9.3,F9.2,/,57X,'BASIN',//)
      GO TO 1500
  600 WRITE(IO,610) I,(DMATX(J,I),J=1,7),(OMATX(J,I),J=1,3),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
  610 FORMAT(1X,1HP,I2,2X,'FLOTATION',10X,'TRR',6X,'TSS',6X,'GTH',
     . 5X,'GSTH',5X,'HPWK',4X,'DPOLY',4X,'CPOLY',/,6X,'THICKENING',5X,
     . F9.2,F9.0,5F9.2,//,24X,'ATHM',7X,'XN',4X,'ATHM1',22X,'CCOST',4X,
     . 'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,21X,3F9.1,18X,
     . F9.0,3F9.3,F9.2,//)
      GO TO 1500
  650 WRITE(IO,660) I,(DMATX(J,I),J=1,9),(OMATX(J,I),J=1,5),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
  660 FORMAT(1X,1HP,I2,2X,'MULTIPLE HEARTH',5X,'ML',5X,'NINC',5X,
     . 'HPWK',5X,'SPER',7X,'WV',7X,'HV',5X,'TYPE',
     . 7X,'FC',6X,'CNG',/,6X,'INCINERATION',3X,7F9.1,2F9.3,//,25X,
     . 'FHA',5X,'WFYR',5X,'PSDD',4X,'ECOST',4X,'FCOST',4X,'CCOST',4X,
     . 'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,21X,5F9.0,
     . F9.0,3F9.3,F9.2,//)
      GO TO 1500
  700 WRITE(IO,710) I,DMATX(1,I),OMATX(1,I),CCOST(I,1),COSTO(I,1),
     . ACOST(I,1),TCOST(I,1),DMATX(16,I)
  710 FORMAT(1X,1HP,I2,2X,'RAW WASTEWATER',4X,'HEAD',7X,'QP',31X,
     . 'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,6X,'PUMPING',
     . 8X,2F9.2,27X,F9.0,3F9.3,F9.2,//)
      GO TO 1500
  750 WRITE(IO,760) I,DMATX(1,I),OMATX(1,I),OMATX(2,I),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
  760 FORMAT(1X,1HP,I2,2X,'SLUDGE HOLDING',6X,'TD',5X,'VSHT',7X,'QP',
     . 22X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,6X,
     . 'TANKS',10X,2F9.1,F9.2,18X,F9.0,3F9.3,F9.2,//)
      GO TO 1500
  800 WRITE(IO,810) I,(DMATX(J,I),J=1,6),(OMATX(J,I),J=1,3),
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
  810 FORMAT(1X,1HP,I2,2X,'CENTRIFUGATION',5X,'CRR',6X,'TSS',5X,
     . 'HPWK',5X,'XCEN',5X,'PCLY',4X,'CPOLY',5X,'CGPM',5X,'DSCL',6X,
     . 'AFC',/,21X,F9.2,F9.0,2F9.1,2F9.2,F9.0,F9.1,F9.5,//,68X,'CCOST',
     . 4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,66X,F9.0,3F9.3,
     . F9.2,//)
      GO TO 1500
  850 WRITE(IO,860) I,(DMATX(J,I),J=1,8),(OMATX(J,I),J=1,4)
  860 FORMAT(1X,1HP,I2,2X,'AEROBIC',13X,'XL',5X,'XAFS',6X,'DTA',5X,
     . 'TSS1',5X,'TSS2',5X,'BOD2',6X,'GSS',5X,'HEAD',/,6X,'DIGESTION',
     . 6X,2F9.0,F9.1,2F9.0,F9.1,2F9.2,//,24X,'VAER',5X,'ACFM',4X,
     . 'QPUMP',6X,'AFS',/,21X,F9.3,F9.0,2F9.2,/)
      WRITE(IO,870)
     . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
     . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I),
     . CCOST(I,3),COSTO(I,3),ACOST(I,3),TCOST(I,3),DMATX(14,I),
     . CCOST(I,4),COSTO(I,4),ACOST(I,4),TCOST(I,4),DMATX(13,I)
  870 FORMAT(68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',
     . /,57X,'AERATOR',2X,F9.0,3F9.3,F9.2,//,57X,'BLOWER',3X,F9.0,
     . 3F9.3,F9.2,//,57X,'SLUDGE',3X,F9.0,3F9.3,F9.2,/,57X,'PUMPS',
     . //,57X,'FINAL',4X,F9.0,3F9.3,F9.2,/,57X,'SETTLER',//)
      GO TO 1500
  900 WRITE(IO,910) I,(DMATX(J,I),J=1,13),(OMATX(J,I),J=1,7)
  910 FORMAT(1X,1HP,I2,2X,'POST AERATION',4X,'ITYPE',8X,'L',5X,'DOIN',
     . 5X,'DOUT',7X,'TL',7X,'TD',7X,'TW',4X,'AERFO',4X,'HPHRO',6X,
     . 'ALT',/,21X,2F9.0,5F9.1,F9.3,2F9.2,//,23X,'CFMDF',4X,'DIFFT',
      . 7X,'DD',5X,'VAER',6X,'CFM',7X,'HP',5X,'TMIN',6X,'VMG',4X,
      . 'AERFF',5X,'CLEN',/,21X,3F9.1,F9.3,F9.0,2F9.2,F9.4,F9.3,F9.2,/)
      WRITE(IO,915) (OMATX(J,I),J=8,13)
  915 FORMAT(25X,'HP1',7X,'XN',6X,'THP',4X,'WIDTH',4X,'DEPTH',5X,
      . 'TLEN',/,21X,F9.2,F9.1,F9.2,2F9.1,F9.2,/)
      WRITE(IO,920) CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),
      . DMATX(16,I),CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),
      . DMATX(15,I)
  920 FORMAT(68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',
      . /,57X,'BASIN',4X,F9.0,3F9.3,F9.2,//,57X,'AIR',6X,F9.0,3F9.3,
      . F9.2,/,57X,'SUPPLY',//)
      GO TO 1500
  950 WRITE(IO,960) I,(DMATX(J,I),J=1,5),(OMATX(J,I),J=1,14)
  960 FORMAT(1X,1HP,I2,2X,'EQUALIZATION',6X,'IAER',6X,'RLW',4X,'COSTL',
      . 5X,'HEAD',5X,'IMAT',4X,'WIDTH',5X,'AREA',5X,'VUMG',5X,'VOMG',7X,
      . 'VT',/,21X,2F9.1,F9.3,2F9.1,F9.2,F9.4,3F9.4,//,23X,
      . 'SAREA',7X,'HP',6X,'HP1',7X,'XN',6X,'THP',4X,'PLAND',4X,'CLAND',
      . 5X,'VAER',5X,'ECFM',/,21X,F9.1,2F9.2,F9.1,2F9.2,F9.0,F9.3,F9.0,/)
      WRITE(IO,970)
      . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
      . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I),
      . CCOST(I,3),COSTO(I,3),ACOST(I,3),TCOST(I,3),DMATX(14,I),
      . CCOST(I,4),COSTO(I,4),ACOST(I,4),TCOST(I,4),
      . CCOST(I,5),COSTO(I,5),ACOST(I,5),TCOST(I,5)
  970 FORMAT(68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',/,
      . 57X,'AERATED',2X,F9.0,3F9.3,F9.2,/,57X,'POND/TANK',//,57X,'AIR',
      . 6X,F9.0,3F9.3,F9.2,/,57X,'SUPPLY',//,57X,'PUMPING',2X,F9.0,
      . 3F9.3,F9.2,/,57X,'SYSTEM',//,57X,'FLOW',5X,F9.0,3F9.3,/,
      . 57X,'MEASURING',//,57X,'POND',5X,F9.0,3F9.3,/,57X,'LINING',//)
      GO TO 1500
 1000 WRITE(IO,1010) I,(DMATX(J,I),J=1,3),OMATX(1,I),
      . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
 1010 FORMAT(1X,1HP,I2,2X,'SECOND STAGE',7X,'TRR',6X,'TSS',7X,'TD',
      . 5X,'VDIG',13X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,
      . 'ECF',/,6X,'ANAEROBIC',6X,F9.2,F9.0,F9.1,F9.0,9X,F9.0,3F9.3,
      . F9.2,/,6X,'DIGESTION',//)
      GO TO 1500
 1050 WRITE(IO,1060) I,(DMATX(J,I),J=1,5),(OMATX(J,I),J=1,9)
 1060 FORMAT(1X,1HP,I2,2X,'LAND DISPOSAL',5X,'TAYR',7X,'SP',5X,'DIST',
      . 7X,'TS',5X,'YRSL',/,21X,3F9.2,F9.0,F9.1,//,25X,'TYT',5X,'TTYR',
      . 5X,'TRKN',6X,'SLV',5X,'TONS',4X,'ALAND',4X,'DLAND',6X,'COL',
      . 6X,'AFT',/,21X,3F9.0,3F9.2,2F9.0,F9.5,/)
      WRITE(IO,1070)
      . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I),
      . CCOST(I,2),COSTO(I,2),ACOST(I,2),TCOST(I,2),DMATX(15,I),
      . CCOST(I,3),COSTO(I,3),ACOST(I,3),TCOST(I,3)
 1070 FORMAT(68X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',6X,'ECF',
      . /,57X,'STORAGE',2X,F9.0,3F9.3,F9.2,/,57X,'LAGOON',//,57X,
      . 'TRUCKING',1X,F9.0,3F9.3,F9.2,//,57X,'INTEREST',1X,F9.0,
      . 3F9.3,/,57X,'ON LAND',//)
      GO TO 1500
 1100 WRITE(IO,1110) I,(DMATX(J,I),J=1,2),(OMATX(J,I),J=1,2),
      . CCOST(I,1),COSTO(I,1),ACOST(I,1),TCOST(I,1),DMATX(16,I)
 1110 FORMAT(1X,1HP,I2,2X,'LIME ADDITION',4X,'DLIME',4X,'CLIME',
      . 5X,'PPDL',5X,'DTON',13X,'CCOST',4X,'COSTO',4X,'ACOST',4X,'TCOST',
      . 6X,'ECF',/,6X,'TO SLUDGE',6X,F9.1,F9.2,F9.1,F9.2,9X,F9.0,3F9.3,
      . F9.2,//)
 1500 CONTINUE
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      WRITE(IO,1510) CCOST(20,1),COSTO(20,1),ACOST(20,1),TCOST(20,1)
 1510 FORMAT(6X,'ADMINISTRATIVE',48X,'CCOST',4X,'COSTO',4X,'ACOST',
     . 4X,'TCOST',/,6X,'AND LABORATORY',46X,F9.0,3F9.3,//)
      WRITE(IO,1520) CCOST(20,2),COSTO(20,2),ACOST(20,2),TCOST(20,2)
 1520 FORMAT(6X,'GARAGE',56X,'CCOST',4X,'COSTO',4X,'ACOST',4X,
     . 'TCOST',/,6X,'AND SHOP',52X,F9.0,3F9.3,//)
      WRITE(IO,1530) DMATX(9,20),CCOST(20,3),COSTO(20,3),ACOST(20,3),
     . TCOST(20,3)
 1530 FORMAT(6X,'LABORATORY',8X,'XLAB',40X,'CCOST',4X,'COSTO',4X,
     . 'ACOST',4X,'TCOST',/,6X,'OPERATION',6X,F9.1,36X,F9.0,3F9.3,//)
      WRITE(IO,1540) CCOST(20,4),COSTO(20,4),ACOST(20,4),TCOST(20,4)
 1540 FORMAT(6X,'YARDWORK',54X,'CCOST',4X,'COSTO',4X,'ACOST',4X,
     . 'TCOST',/,6X,'OPERATION',51X,F9.0,3F9.3,//)
      WRITE(IO,1600) (OMATX(J,20),J=17,20)
 1600 FORMAT(1H1,//////,52X,'TOTAL PLANT COST',///,
     . 39X,'TOTAL CAPITAL COST = ',F10.0,' DOLLARS',
     . //,34X,'TOTAL AMORTIZATION COST = ',F10.3,' CENTS/1000 GAL.',//,
     . 41X,'TOTAL O + M COST = ',F10.3,' CENTS/1000 GAL.',//,37X,
     . 'TOTAL TREATMENT COST = ',F10.3,' CENTS/1000 GAL.',/////)
      WRITE(IO,1610) (DMATX(J,20),J=1,10),(OMATX(J,20),J=1,12)
 1610 FORMAT(7X,'CCI',9X,'WPI',10X,'RI',9X,'YRS',9X,'DHR',9X,'PCT',
     . 10X,'DA',7X,'CCINT',8X,'XLAB',8X,'CKWH',//,3F12.3,F12.1,F12.2,
     . F12.3,F12.0,2F12.2,F12.3,/////,5X,'RATIO',8X,'TCAP',8X,'YARD',
     . 9X,'TCC',7X,'XLAND',9X,'ENG',7X,'SUBT1',8X,'FISC',7X,'SUBT2',
     . 8X,'XINT',//,F12.3,9F12.0,///,6X,'ACRE',10X,'AF',//,F12.2,F12.5)
      RETURN
      END
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